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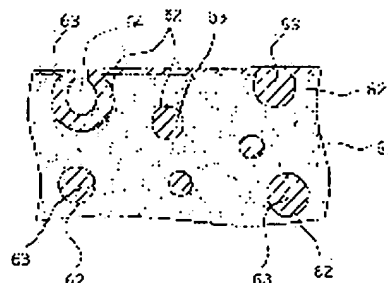
JP

(54) CERAMIC ELECTRONIC COMPONENT AND ITS MANUFACTURING METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a ceramic electronic component having the low dielectric constant of a ceramic sintered body and excellent impedance properties in a GHz zone and capable of obtaining high impedance properties in a wide frequency range, and its manufacturing method.

SOLUTION: A compounded ceramic raw material with a ceramic raw material, a binder, and a burnt material that is spherical or granular in shape and has adhesive properties to the binder compounded is used to form a



molded body having a structure with an electrode arranged inside. This molded body is calcined to form a ceramic sintered body including holes of 35 to 80 vol%. After that, the ceramic sintered body is filled with a resin or glass, thereby reducing a dielectric constant to inhibit the occurrence of suspension capacity without causing a reduction in strength of the ceramic sintered body.

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(54) 【発明の名称】 セラミック電子部品及びその製造方法

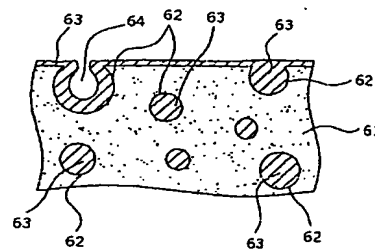
(57) 【要約】

【課題】セラミック焼結体の誘電率が低く、GHz帯でのインピーダンス特性に優れ、広い周波数範囲で高いインピーダンス特性を得ることが可能なセラミック電子部品及びその製造方法を提供する。

【解決手段】セラミック原料と、バインダーと、球状又は粉粒体状で、バインダーに対する接着性を有する焼失材とを配合した配合セラミック原料を用いて、内部に電極が配設された構造を有する成形体を形成し、この成形体を焼成することにより35～80vol%の空孔を含むセラミック焼結体を形成した後、セラミック焼結体に樹脂又はガラスを充填させることにより、セラミック焼結体の強度低下を招くことなく、誘電率を低下させて浮遊容量の発生を抑制する。

【選択図】

図6



【特許請求の範囲】

【請求項 1】

35～80 vol %の割合で空孔を含むセラミック焼結体と、
前記セラミック焼結体の内部に配設された電極と、
を有し、前記セラミック焼結体の前記空孔に、樹脂又はガラスが充填されていること
を特徴とするセラミック電子部品。

【請求項 2】

前記セラミック焼結体が、セラミック原料と、バインダーと、球状又は粉粒体状で前記バ
インダーに対する接着性を有する焼失材とを配合してなる配合セラミック原料の成形体を
焼成することにより、35～80 vol %の空孔を形成したものであることを特徴とする 10
請求項 1 記載のセラミック電子部品。

【請求項 3】

前記空孔に充填された樹脂又はガラス中に、さらに空孔が含まれていることを特徴とする
請求項 1 又は 2 記載のセラミック電子部品。

【請求項 4】

前記セラミック焼結体を構成するセラミックが磁性体セラミックであることを特徴とする
請求項 1～3 のいずれかに記載のセラミック電子部品。

【請求項 5】

前記セラミック電子部品は、インダクタ、インダクタ部とコンデンサ部を組み合わせた LC 複合電子部品、インダクタ部と抵抗を組み合わせた LR 複合電子部品、又はインダクタ 20
部とコンデンサ部と抵抗を組み合わせた LCR 複合電子部品であることを特徴とする請求
項 1～4 のいずれかに記載のセラミック電子部品。

【請求項 6】

複数のセラミック層間に電極層を配した積層構造を有する積層セラミック電子部品である
ことを特徴とする請求項 1～5 のいずれかに記載のセラミック電子部品。

【請求項 7】

前記空孔の平均径が 5～20 μm であることを特徴とする請求項 1～6 のいずれかに記載
のセラミック電子部品。

【請求項 8】

前記セラミック焼結体の表面が前記樹脂又はガラスで覆われていることを特徴とする請求 30
項 1～7 のいずれかに記載のセラミック電子部品。

【請求項 9】

セラミック焼結体の内部に電極が配設された構造を有するセラミック電子部品の製造方法
であって、

セラミック原料と、バインダーと、球状又は粉粒体状で、前記バインダーに対する接着性
を有する焼失材とを配合した配合セラミック原料を用いて、内部に電極が配設された成形
体を形成する工程と、

前記成形体を焼成することにより、35～80 vol %の空孔を含み、かつ内部に電極が
配設されたセラミック焼結体を形成する工程と、

前記セラミック焼結体の前記空孔に樹脂又はガラスを充填させる工程と
を具備することを特徴とするセラミック電子部品の製造方法。 40

【請求項 10】

前記焼失材が、架橋ポリスチレン、架橋ポリメタクリル酸メチル、架橋ポリメタクリル酸
ブチル、架橋ポリメタクリル酸エステル、架橋ポリアクリル酸エステルからなる群より選
ばれる少なくとも 1 種を主成分とするものであることを特徴とする請求項 9 記載のセラミ
ック電子部品の製造方法。

【請求項 11】

前記セラミック焼結体の前記空孔に樹脂又はガラスを充填させる工程において、
前記樹脂又はガラスとして、溶剤又は希釈剤を配合した樹脂又はガラスを用い、前記空孔
に樹脂又はガラスを充填した後に、前記溶剤又は希釈剤を揮発させることにより、樹脂又 50

はガラス中にさらに空孔を形成すること
を特徴とする請求項 9 又は 10 記載のセラミック電子部品の製造方法。

【請求項 12】

前記セラミック焼結体の前記空孔に樹脂又はガラスを充填させる工程において、前記樹脂又はガラスとして、溶剤により一部を溶出させることができる樹脂又はガラスを用い、前記空孔に該樹脂又はガラスを充填した後に、溶剤により樹脂又はガラスの一部を溶出させて除去することにより、前記樹脂又はガラス中にさらに空孔を形成することを特徴とする請求項 9～11 のいずれかに記載のセラミック電子部品の製造方法。

【請求項 13】

前記セラミック原料として磁性体セラミック原料を用いることを特徴とする請求項 9～12 のいずれかに記載のセラミック電子部品の製造方法。

【請求項 14】

インダクタ、インダクタ部とコンデンサ部を組み合わせた LC 複合電子部品、インダクタ部と抵抗を組み合わせた LR 複合電子部品、又はインダクタ部とコンデンサ部と抵抗を組み合わせた LCR 複合電子部品を製造するために用いられるものであることを特徴とする請求項 9～13 のいずれかに記載のセラミック電子部品の製造方法。

【請求項 15】

前記成形体を、前記配合セラミック原料からなるセラミックグリーンシート上に電極層を形成し、電極層を有するセラミックグリーンシートを複数積層することによって作製することを特徴とする請求項 9～14 のいずれかに記載のセラミック電子部品の製造方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】

本願発明は、セラミック電子部品及びその製造方法に関し、詳しくは、GHz 帯等の、高周波帯域でのインピーダンス特性に優れ、広い周波数範囲で高いインピーダンスを得ることが可能なインダクタなどのセラミック電子部品及びその製造方法に関する。

【0002】

【従来の技術】

近年、電子機器の高周波化が進み、インダクタや、LC 複合部品、LR 複合部品、LCR 複合部品などは、GHz 帯域の高周波に対応可能なものが求められるようになってきている。

【0003】

しかし、高周波帯域用のインダクタにおいては、コイルとバラレルに発生する浮遊容量が、そのインピーダンスに大きく影響し、特に GHz 帯では、 $1/100\text{ pF} \sim 1/10\text{ pF}$ 程度の微小な浮遊容量がインピーダンスに大きな影響を与える。したがって、浮遊容量を小さくして所望の特性を確保しようとする、磁性体として用いられているフェライトなどの誘電率 ϵ を下げることが必要になる。しかし、フェライトの構造的な理由から、フェライト自体の誘電率 ϵ を例えば 13～14 以下にまで下げることは事実上困難である。

【0004】

そのような状況のもとで誘電率 ϵ を下げようとする、磁性体に樹脂やガラスなどの誘電率の低い材料を配合する方法が考えられるが、磁性体に非磁性体である樹脂やガラスなどを配合したコンポジット磁性材料においては、磁性体粒子が樹脂やガラスなどの非磁性体材料によって覆われ、磁路が分断されてしまうため、透磁率が極端に低くなってしまうという問題点がある。

【0005】

また、近年、電波吸収体などに用いられる誘電率の低いフェライト材料として、空孔率を 20～70% とした発泡フェライト焼結体が知られている（例えば、特許文献 1 参照）。このフェライト焼結体は、空孔を高い割合で含んでいることから誘電率が低く、また、磁路が連続していることから、電磁気特性が不連続に大きく変動することがないという特徴を有している。すなわち、この発泡フェライト焼結体は、空孔率が高くなっても個々のフェライト粒子どうしは磁氣的に結合されているため、フェライト粉末と絶縁物との混合フ

ェライトの場合に見られるようなフェライト複素透磁率の周波数分散特性の変動は少ないという特徴を有している。

【0006】

また、空孔を含有させたセラミックを用いた電子部品として、セラミックと、セラミックの内部に形成された内部電極を備え、セラミックに直径1～3 μ mの空孔（ポア）を3～30体積%の割合で含有させたセラミック電子部品が提案されている（例えば、特許文献2参照）。

【0007】

このセラミック電子部品は、セラミックに直径1～3 μ mのポアを3～30体積%の割合で含有させるようにしているので、セラミックの誘電率を下げる事が可能になり、それ 10
だけインピーダンス特性を向上させることが可能になるという特徴を有している。

【0008】

【特許文献1】

特開昭55-526300号公報

【特許文献2】

特開平11-67575号公報

【0009】

【発明が解決しようとする課題】

しかし、特許文献1の発泡フェライト焼結体においては、空孔率を高くしようとすると成形体の機械的強度が低下するため、このままでは、電子部品材料として、必要な抗折強度 20
を確保することが困難であるという問題点がある。

【0010】

また、特許文献2のセラミック電子部品においては、ポアの含有割合が30体積%を超えるとセラミック素体の抗折強度が低下することを考慮して、ポアの含有割合が3～30体積%の範囲とされているため、比誘電率の低減の範囲が制約され、近年の、さらに高い特性を備えたセラミック電子部品への要求を必ずしも十分に満たすことができないのが実情である。

【0011】

また、特許文献2のセラミック電子部品には、セラミックに含まれる空孔に水分が入り込みやすく、吸水率が高くなるため、信頼性が低下するという問題点がある。 30

【0012】

本願発明は、上記問題点を解決するものであり、誘電率が低く、高強度のセラミック焼結体を備えるセラミック電子部品及びその製造方法を提供することを目的とする。

【0013】

【課題を解決するための手段】

上記目的を達成するため、本願発明（請求項1）のセラミック電子部品は、
35～80vol%の割合で空孔を含むセラミック焼結体と、

前記セラミック焼結体の内部に配設された電極と、

を有し、前記セラミック焼結体の前記空孔に、樹脂又はガラスが充填されていること
を特徴としている。 40

【0014】

本願発明（請求項1）のセラミック電子部品によれば、セラミック焼結体が35～80vol%の割合で空孔を含むとともに、セラミック焼結体の空孔に樹脂又はガラスが充填されているので、セラミック焼結体の強度低下を招くことなく、その誘電率を低下させることが可能になる。

【0015】

すなわち、本願発明（請求項1）のセラミック電子部品においては、セラミック焼結体に35～80vol%の割合で空孔を含ませることにより、セラミック焼結体中のセラミックグレインの連続性を確保して、セラミック焼結体の各種電気特性を低下させることなく、セラミック焼結体の誘電率を大幅に低下させることが可能になる一方、セラミック焼結 50

体の前記空孔に樹脂又はガラスが充填されているので、セラミック焼結体の強度を確保することが可能になり、各種の電気特性に優れ、かつ、機械的強度の大きい信頼性の高いセラミック電子部品を得ることが可能になる。

【0016】

なお、本願発明は、フェライトなどのセラミック材料は圧縮応力には強いが、引張り応力には弱いことに着目し、微量であっても、空孔内に樹脂又はガラスを充填させることにより、引張り耐力を補強できることを利用したものであって、本願発明によれば、従来の空孔率を30vol%としたものよりも大きな機械的強度（抗折強度など）を確保しつつ、空孔率を80%にまで高めることが可能になり、電気特性の劣化を招くことなく、誘電率を特に6以下にまで下げることが可能になる。

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【0017】

また、本願発明のセラミック電子部品において、セラミック焼結体が磁性体セラミックの場合、セラミック焼結体に空孔を含ませるようにしていることから、磁性体の透磁率もいくらか低下する。しかしながら、磁性体セラミックには連続した磁路が形成されているため、磁性体の持つ透磁率の特性を維持することが可能になる（すなわち、 μ' と μ'' が同じ値になるクロスポイント周波数がほとんど変化しない）。

【0018】

また、空孔の体積含有率（空孔率）は、セラミック焼結体の誘電率を十分に低下させて所望の特性を確保する見地から、35vol%以上とすることが必要である。また、空孔率が80vol%を超えると、焼成後の強度が低下し、その後の樹脂、ガラス含浸加工等の方法による充填が困難になるため、80vol%以下とすることが必要である。

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なお、本願発明においては、空孔率を40～50vol%の範囲とすることが望ましい。なお、空孔内に充填された樹脂又はガラスがセラミック焼結体の強度を補う機能を果たすため、空孔形成後のセラミック焼結体の強度は多少弱くても特に問題はなく、空孔径が5～20 μ mで、セラミック焼結体の空孔率が80vol%までの範囲であれば加工は可能である。

【0019】

また、請求項2のセラミック電子部品は、前記セラミック焼結体が、セラミック原料と、バインダーと、球状又は粉粒体状でバインダーに対する接着性を有する焼失材とを配合してなる配合セラミック原料の成形体を焼成することにより、35～80vol%の空孔を形成したものであることを特徴としている。

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【0020】

請求項2のセラミック電子部品は、セラミック焼結体が、セラミック原料と、バインダーと、球状又は粉粒体状でバインダーに対する接着性を有する焼失材とを配合した配合セラミック原料の成形体を焼成することにより形成されており、特にセラミック焼結体が磁性体セラミックの場合、磁路を分断しない程度の35～80vol%の空孔を含有していることから、所望の磁性特性を備え、浮遊容量の発生が少なく、所望の特性を備えた信頼性の高いセラミック電子部品を提供することができるようになる。

【0021】

また、請求項3のセラミック電子部品は、前記空孔に充填された樹脂又はガラス中に、さらに空孔が含まれることを特徴としている。

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【0022】

前記空孔に充填された樹脂又はガラス中に、さらに空孔を含ませることにより、セラミック焼結体の誘電率をさらに低下させることが可能になり、本願発明をさらに実効あらしめることができる。

【0023】

また、請求項4のセラミック電子部品は、前記セラミック焼結体を構成するセラミックが磁性体セラミックであることを特徴としている。

【0024】

インダクタなどを製造する場合には、セラミック焼結体を構成するセラミック原料として

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磁性体セラミックが用いられるが、そのような場合に本願発明を適用することにより、セラミック焼結体の機械的な強度の低下を招くことなく、誘電率を低下させて浮遊容量の発生を抑制することが可能になり、所望の特性を備えた信頼性の高いセラミック電子部品（インダクタなど）を提供することが可能になる。

【0025】

また、請求項5のセラミック電子部品は、インダクタ、インダクタ部とコンデンサ部を組み合わせたLC複合電子部品、インダクタ部と抵抗を組み合わせたLR複合電子部品、又はインダクタ部とコンデンサ部と抵抗を組み合わせたLCR複合電子部品であることを特徴としている。

【0026】

すなわち、本願発明は、インダクタ、LC複合電子部品、LR複合電子部品又はLCR複合電子部品などの種々のセラミック電子部品に適用することが可能であり、セラミック焼結体の強度が大きくて、浮遊容量の発生が少ない、所望の特性を備えた電子部品を提供することが可能になる。

【0027】

また、請求項6のセラミック電子部品は、複数のセラミック層間に電極層を配した積層構造を有する積層セラミック電子部品であることを特徴としている。

【0028】

すなわち、本願発明は、複数のセラミック層間に電極層を配した積層構造を有し、セラミック焼結体の抗折強度などが問題になりやすい積層セラミック電子部品に好適に適用することが可能であり、本願発明を適用することにより、誘電率の低いセラミック層を積層してなり、かつ、機械的強度が大きくて信頼性の高い積層セラミック電子部品を提供することが可能になる。

【0029】

また、請求項7のセラミック電子部品は、前記空孔の平均径が $5 \sim 20 \mu\text{m}$ であることを特徴としている。

【0030】

本願発明においては、セラミック焼結体の空孔の寸法（空孔径）は $5 \sim 20 \mu\text{m}$ とすることが好ましいが、これは、空孔径が $5 \mu\text{m}$ 以下になると、閉空孔になりやすく、空孔内に樹脂又はガラスを十分に充填させることができなくなり、また、空孔径が $20 \mu\text{m}$ を超えると、焼成後の空孔が形成された磁性体自体の強度が弱くなり加工が困難になることによる。なお、この空孔の平均径は、 $5 \sim 10 \mu\text{m}$ の範囲とすることがさらに好ましい。

【0031】

また、請求項8のセラミック電子部品は、前記セラミック焼結体の表面が前記樹脂又はガラスで覆われていることを特徴としている。

【0032】

本願発明のセラミック電子部品においては、セラミック焼結体の全表面が樹脂又はガラスで覆われていることが特に好ましいが、表面のうち一部だけが覆われた構成とすることも可能である。これにより、セラミック焼結体の強度をさらに向上させることができる。

【0033】

また、請求項9のセラミック電子部品の製造方法は、セラミック焼結体の内部に電極が配設された構造を有するセラミック電子部品の製造方法であって、セラミック原料と、バインダーと、球状又は粉粒体状で、前記バインダーに対する接着性を有する焼失材とを配合した配合セラミック原料を用いて、内部に電極が配設された成形体を形成する工程と、前記成形体を焼成することにより、 $35 \sim 80 \text{ vol} \%$ の空孔を含み、かつ内部に電極が配設されたセラミック焼結体を形成する工程と、前記セラミック焼結体の前記空孔に樹脂又はガラスを充填させる工程とを具備することを特徴としている。

【0034】

本願発明のセラミック電子部品の製造方法は、セラミック原料と、バインダーと、球状又は粉粒体状で、バインダーに対する接着性を有する焼失材とを配合したセラミック焼結体用の配合セラミック原料を用いて、内部に電極（電極材料）が配設された成形体を形成し、この成形体を焼成することにより35～80vol%の空孔を含むセラミック焼結体を形成した後、セラミック焼結体の空孔に樹脂又はガラスを充填させるようにしているため、セラミック焼結体中のセラミックグレインの連続性を確保しつつ、セラミック焼結体に空孔を形成して、セラミック焼結体の各種電気特性を大きく低下させることなく、セラミック焼結体の誘電率を大幅に低下させることが可能になるとともに、空孔中に充填させた樹脂又はガラスにより、セラミック焼結体の強度を向上させることが可能になり、所望の特性を備えた信頼性の高いセラミック電子部品の効率よく製造することが可能になる。また、本願発明においては、焼失材として、球状又は粉粒体状のいずれの形態のものも用いることが可能であるが、分散の均一性などの見地からは球状のものを用いることがより好ましい。

また、焼失材としては、セラミック焼結体に、空孔径が5～20 μ mの空孔を形成する見地から、平均粒径が5～20 μ mのものを用いることが望ましい。

また、所望の空孔率を実現する見地から、焼失材は、通常、前記配合セラミック原料中で35～80vol%となるような割合で配合することが望ましく、特に、40～50vol%となるように配合することが望ましい。なお、焼失材は目標とする空孔率に応じて、適宜配合することが可能である。

【0035】

また、請求項10のセラミック電子部品の製造方法は、前記セラミック原料に配合される焼失材が、架橋ポリスチレン、架橋ポリメタクリル酸メチル、架橋ポリメタクリル酸ブチル、架橋ポリメタクリル酸エステル、架橋ポリアクリル酸エステルからなる群より選ばれる少なくとも1種を主成分とするものであることを特徴としている。

【0036】

セラミック原料に配合される焼失材として、架橋ポリスチレン、架橋ポリメタクリル酸メチル、架橋ポリメタクリル酸ブチル、架橋ポリメタクリル酸エステル、架橋ポリアクリル酸エステルからなる群より選ばれる少なくとも1種を主成分とするものを用いた場合、焼成工程で焼失材が確実に焼失して、セラミック焼結体に確実に空孔を形成することが可能になり、所望の空孔率を有するセラミック焼結体を効率よく形成することが可能になる。

【0037】

なお、空孔率を大幅に増大させるためには、焼失材の割合を増やす必要があり、セラミックの割合を確保しつつ焼失材を大幅に増やすためにはバインダーの割合を減らすことが必要になるが、バインダーの割合を減らすと、焼結前の半製品の強度が低下し、加工工程での歩留まりが低下する傾向がある。しかし、焼失材として、表面積が大きく樹脂バインダーに対する接着性に優れ、保形性の大きい架橋ポリマーを採用することにより、歩留まりを低下させることなく、バインダーの割合を減らして焼失材の割合を増やすことが可能になり、空孔率を高めることが可能になる。

【0038】

また、請求項11のセラミック電子部品の製造方法は、セラミック焼結体の空孔に樹脂又はガラスを充填させる工程において、樹脂又はガラスとして、溶剤又は希釈剤を配合した樹脂又はガラスを用い、空孔に樹脂又はガラスを充填した後に、溶剤又は希釈剤を揮発させることにより、樹脂又はガラスにさらに空孔を形成することを特徴としている。

【0039】

セラミック焼結体の空孔に樹脂又はガラスを充填させる工程において、樹脂又はガラスとして、溶剤又は希釈剤を配合した樹脂又はガラスを用い、樹脂又はガラスを充填した後に、溶剤又は希釈剤を揮発させることにより、樹脂又はガラス中にさらに空孔を形成するこ

とが可能になり、セラミック焼結体の誘電率をさらに低下させることが可能になる。

【0040】

なお、溶剤又は希釈材としては、例えば、エタノール、キシレン、酢酸ブチル、水などを用いることが可能である。

また、溶剤又は希釈剤は、樹脂又はガラス100に対して体積比で、5～50の範囲で配合することが望ましい。これは、配合割合が、樹脂又はガラス100に対して体積比で5未満になると希釈後の粘度低減の効果が不十分で、作業性が低下し、また、50を超えると樹脂硬化時に希釈材が樹脂内部に残り、樹脂の特性が劣化することによる。

【0041】

また、請求項12のセラミック電子部品の製造方法は、前記セラミック焼結体に樹脂又はガラスを充填させる工程において、樹脂又はガラスとして、溶剤により一部を溶出させることができる樹脂又はガラスを用い、該樹脂又はガラスを充填した後に、溶剤により樹脂又はガラスの一部を溶出させて除去することを特徴としている。

【0042】

セラミック焼結体の空孔に樹脂又はガラスを充填させる工程において、溶剤により一部を溶出させることができる樹脂又はガラスを用い、該樹脂又はガラスを充填した後に、溶剤により樹脂又はガラスの一部を溶出させることにより、セラミック焼結体の空孔に充填させた樹脂又はガラスの一部が除去されることになる。したがって、セラミック焼結体の誘電率をさらに低下させることが可能になり、本願発明をさらに実効あらしめることができる。

なお、溶剤により一部を溶出させることができる樹脂又はガラスとは、必ず樹脂自体やガラス自体が溶解するものに限らず、例えば、樹脂に関しては、樹脂に配合した一部材料などが溶剤に溶解して除去されるもの、また、ガラスに関しては、溶剤によりガラス原料の基材の一部などが溶解することにより、ガラス自体もその一部が除去されるようなものなどを含む広い概念である。

【0043】

また、請求項13のセラミック電子部品の製造方法は、前記セラミック原料が磁性体セラミック原料であることを特徴としている。

【0044】

インダクタなどを製造する場合には、セラミック焼結体を構成するセラミック原料として磁性体セラミックが用いられるが、そのような場合に本願発明を適用することにより、セラミック焼結体の機械的な強度の低下を招くことなく、誘電率を低下させて浮遊容量の発生を抑制することが可能になり、所望の特性を備えた信頼性の高いセラミック電子部品を効率よく製造することが可能になる。

【0045】

また、請求項14のセラミック電子部品の製造方法は、インダクタ、インダクタ部とコンデンサ部を組み合わせたLC複合電子部品、インダクタ部と抵抗を組み合わせたLR複合電子部品、又はインダクタ部とコンデンサ部と抵抗を組み合わせたLCR複合電子部品を製造するために用いられるものであることを特徴としている。

【0046】

本願発明のセラミック電子部品の製造方法は、インダクタ、LC複合電子部品、LR複合電子部品、LCR複合電子部品などの種々の電子部品を製造する場合に適用することが可能であり、セラミック焼結体の強度低下を招くことなく、誘電率を低下させ、浮遊容量が小さく、所望のインピーダンス特性を備えた信頼性の高いインダクタ、LC複合電子部品、LR複合電子部品、LCR複合電子部品などを効率よく製造することができるようになる。

【0047】

また、請求項15のセラミック電子部品の製造方法は、前記成形体を、前記配合セラミック原料からなるセラミックグリーンシート上に電極層を形成し、電極層を有するセラミックグリーンシートを複数積層することによって作製することを特徴としている。

【0048】

本願発明のセラミック電子部品の製造方法は、複数のセラミック層間に電極層を配した積層構造を有し、セラミック焼結体の抗折強度などが問題になりやすい積層セラミック電子部品の製造する場合に好適に適用することが可能であり、本願発明を適用することにより、インピーダンス特性に優れ、かつ、機械的強度が大きくて信頼性の高い積層セラミック電子部品の効率よく製造することが可能になる。

【0049】

【発明の実施の形態】

本願発明のセラミック電子部品におけるセラミック焼結体について、図6を参照して説明する。

図6に示すように、本願発明におけるセラミック焼結体61の内部には複数の空孔62が形成されている。空孔62には、樹脂又はガラス63が充填されており、セラミック焼結体の表面も樹脂又はガラス63によって覆われている。

空孔62は、その平均径が5～20 μ mであり、セラミック焼結体61において35～80vol%の割合で形成されている。なお、空孔62は、開空孔（オープンポア）及び閉空孔（クローズドポア）を含む。

この空孔のうち、30～70vol%は、樹脂又はガラス63で充填されている。すなわち、空孔62には、その内部全体に樹脂又はガラス63が充填されていてもよいが、その内部の一部のみに充填されていてもよく、その場合には、空孔62内に充填された樹脂又はガラス63中にさらに空孔64が形成される。

なお、樹脂又はガラス中に空孔を形成する場合の態様としては、図6に示したような外部に開口した空孔を形成してもよく、樹脂又はガラス中に分散した多数の空孔を形成してもよい。

また、セラミック焼結体には、磁性体セラミック、誘電体セラミック、半導体セラミック、圧電体セラミックなど、各種の機能性セラミックを適用することができる。

以下、本願発明の実施の形態を示して、その特徴とするところをさらに詳しく説明する。

【0050】

【実施形態1】

<1>空孔を有するセラミック焼結体の作製

なお、この実施形態1では、空孔を有するセラミック焼結体を形成する方法について説明する。

【0051】

(1) まず、透磁率 μ が400のNiZnCuフェライト材料を得るため、ニッケル、亜鉛及び銅の酸化物原料を混合して800℃、1時間仮焼した。

(2) その後、ボールミルにより粉碎し、乾燥することにより、平均粒径約2 μ mのフェライト原料（酸化物混合粉末）を得た。

(3) それから、得られたフェライト原料に市販の球状ポリマー（この実施形態1では、架橋ポリスチレンからなる球状の焼失材（平均粒径＝8 μ m、商品名：テクポリマー（TECHPOLYMER）、積水化成工業株式会社（SEKISUI PLASTICS CO., LTD.）製）を表1に示すように種々の割合で添加し、溶媒、バインダー、分散剤を加えて混合し、配合セラミック原料を作製した後、この配合セラミック原料を用いてドクターブレード法により厚さ100 μ mのセラミックグリーンシートを作製した。

なお、焼失材（空孔形成材）として、表面積が大きくバインダーに対する接着性に優れ、保形性の大きい球状ポリマーを採用することにより、歩留まりを低下させることなく、バインダーの割合を減らして焼失材の割合を増やすことが可能になり、空孔率を高めることが可能になる。

(4) 次に、得られたセラミックグリーンシートを積層、圧着して厚みが2mmの成形体（積層体）を得た。そして、この成形体からリング形状と円板状と角板状のテストピースを作製した。

(5) そして、これを400℃で3時間熱処理して脱バインダーを行った後、900℃で2時間焼成することによりセラミック焼結体を得た。

なお、この実施形態1では、混合する有機材料（特に焼失材）の量を変化させることにより空孔の割合を調整した。例えば、配合セラミック原料中の焼失材の割合を50vol%にすれば、セラミック焼結体中の空孔の割合はほぼ50vol%となる。

また、セラミック焼結体の空孔の体積含有率（空孔率）は、空孔（空気）の比重を0g/cm³、フェライトの比重（実測値）を5.02g/cm³として、セラミック焼結体の比重から算出した。

(6) それから、得られたセラミック焼成体を、誘電率3.9の水溶性ガラス（この実施形態1ではLi-K系ガラス）中に含浸させ、空孔内にガラスを充填するとともにセラミック焼結体表面にガラス膜を形成した後、800℃でガラスの溶融・焼付けを行った。

【0052】

空孔にガラスを充填させ、溶融・焼き付けを行った後の誘電率、透磁率、抗折強度及び吸水率の測定結果を表1に示す。

【0053】

【表1】

試料 No.	球状 ポリ マー 平均 粒径 (μm)	空孔径 (μm)	空孔率 (vol%)	空孔にガラス含浸			吸水率 (%)		抗折強度 (MPa)	
				誘電率 1MHz	複素透磁率		含浸 前	含浸 後	含浸 前	含浸 後
					1MHz	1GHz				
1	-	-	0	14.5	430	11	0.20	-	80	-
2	8	7	10	14.0	320	7.9	1.89	0.19	74	81
3	8	7	30	11.0	220	6.6	3.72	0.12	59	82
4	8	7	35	9.9	175	5.5	4.39	0.10	51	82
5	8	7	40	9.0	150	4.8	5.75	0.08	46	82
6	8	7	50	8.1	119	3.5	10.0	0.08	34	84
7	8	7	60	7.0	89	2.9	16.4	0.07	19	84
8	8	7	70	6.3	59	2.2	18.9	0.07	14	84
9	8	7	80	5.8	49	1.8	19.5	0.07	10	84

【0054】

なお、透磁率はリング状のテストピース、誘電率は円板状のテストピース、抗折強度は角板状のテストピースをそれぞれ用いて測定した。

表1に示すように、セラミック焼結体の空孔率が高くなるにともなって、誘電率は低くなるが、ガラスを充填させない状態における抗折強度が低下し、吸水率が増大する。一方、セラミック焼結体の空孔にガラスを充填させた場合には、抗折強度の低下や吸水率の増大を招くことなく、誘電率を低下させることが可能になる。

すなわち、上記実施形態1の場合のように、空孔内にガラスを充填した場合、試料番号1の空孔を含まないセラミック焼結体と比べて、抗折強度を同等又はそれ以上に向上させることが可能になるとともに、吸水率を低く抑えることが可能になる。

また、表1の試料番号3に示すように、空孔率が30 vol %になると、誘電率が11.0と高くなり、十分に誘電率を低下させることができなくなることがわかる。

また、表1の試料番号9に示すように、空孔率が80 vol %になると、誘電率を6以下にまで低くする（空孔率が80 vol %の場合の誘電率：5.8）ことが可能になることがわかる。ただし、空孔率が80 vol %を超えると、焼成後の強度が低下し、その後の樹脂、ガラス含浸加工等が困難になるため好ましくない。

【0055】

なお、表1には示していないが、誘電率を下げるために、ガラスをフェライト原料に添加、混合した後、焼成したコンポジット材や磁粉に樹脂を混練成形した材料では、表1の空孔にガラスを含浸（充填）させた場合と同等の比率で、フェライトにガラスや樹脂を添加、混合しても、表1に示すような透磁率は得られないことが確認されている。

例えば、ガラスをフェライト原料に添加、混合した後、焼成したコンポジット材にあっては、ガラスの混合率を50 vol %とした場合に、透磁率 μ は4程度にしかならず、また、透磁率の周波数特性においても、複素透磁率 μ'' がほとんど発現しなくなってしまうことが確認されている。これは、磁粉をガラスや樹脂に分散させて成形体とした場合、磁粉を覆い固めるように、ガラスや樹脂が分布するため、磁性体から形成される磁路が非磁性材であるガラスや樹脂によって分断されるため透磁率が低くなることによるものと考えられる。

これに対して、上記実施形態1にかかる方法で調製した、空孔を有するセラミック焼結体（空孔形成材料）においては、磁性体自体の透磁率の特徴が保持される。これは、セラミック焼結体内で磁路が分断されずに繋がった状態が保たれるため、高い透磁率が得られ、かつ、磁性体自体の透磁率の特徴も保持されることによるものと考えられる。

【0056】

<2>チップコイル部品の作製

(1) 上記<1>の表1、試料番号6の材料（すなわち、空孔率が50 vol %のセラミック焼結体）を用いて形成したセラミックグリーンシートに、内部コイルを構成する電極となる銀ペーストを印刷し、積層、圧着した後、チップ状にカットして900℃で焼成した。

これにより、焼成時に空孔形成材が焼失して、銀系の内部電極を有し、50 vol %の割合で空孔を含んだセラミック焼成体が得られる。

(2) 次に、セラミック焼結体を、誘電率3.9の水溶性ガラス（この実施形態1ではLi-K系ガラス）に浸漬し、空孔内部に水溶性ガラスを充填させた。

(3) それから、セラミック焼結体の、コイルの軸心方向に平行な両端側に内部電極と導通するように外部電極用の導電ペーストを塗布した後、800℃で熱処理することにより、空孔に充填させたガラス及び導電ペーストを同時に焼成した。これにより、図1に示すように、セラミック焼結体1の内部にコイル2が配設され、セラミック焼結体の両端部に外部電極3a、3bが配設された構造を有する、長さ1.6mm、幅及び高さ0.8mmのチップコイル部品（実施例1）を得た。なお、この実施例1のチップコイル部品においては、コイルのターン数を30ターンとした。

【0057】

また、比較のため、通常のフェライト材（前記<1>の表1、試料番号1の空孔率が0 vol %のセラミック焼結体）からなるセラミックグリーンシートを用いて、上記実施例1と同じ方法で、チップコイル部品（比較例1）を作製した。なお、特性の比較を容易にするため、低周波帯域におけるインダクタンスが近い値となるように、比較例1のチップコイル部品では、コイルのターン数を20ターンとした。

【0058】

この実施例1及び比較例1のチップコイル部品をネットワークアナライザHP8753D

に接続して反射特性を測定し、その結果からインピーダンスを算出した。図 2 に、実施例 1 及び比較例 1 のチップコイル部品のインピーダンス特性を示す。

【0059】

この実施例 1 のチップコイル部品においては、空孔を形成することにより、透磁率の特性を損なうことなく誘電率を低下させた磁性体を用いているので、低周波領域では、従来と同様のインピーダンス特性を維持したまま、低誘電率化によって、高周波領域まで所望のインピーダンスを確保できることがわかる。

すなわち、比較例 1 のチップコイル部品では、 600Ω のインピーダンスが得られる周波数は 1.3GHz 程度までであるが、実施例 1 のチップコイル部品では、 600Ω のインピーダンスが得られる帯域が約 4GHz まで拡大していることがわかる。

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【0060】

また、この実施例 1 のチップコイル部品においては、セラミック焼結体の空孔内部にガラスを充填させているので、従来の空孔を含まないフェライト材を用いた比較例 1 のチップコイル部品と比べて抗折強度に遜色がなく、また、吸水率に関しては、比較例 1 のチップコイル部品よりも低くなっており、信頼性の面でも比較例 1 より優れていることが確認されている。

【0061】

【実施形態 2】

<1>空孔を有するセラミック焼結体の作製

(1) 上記実施形態 1 と同様にして、混合する有機材料の量を変化させることにより空孔の割合を調整して、実施形態 1 の<1>の(5)で得たものと同じセラミック焼結体を作製した。

(2) それから、セラミック焼結体の空孔に、誘電率 3.4 のエポキシ樹脂を含浸させた後、 150°C に加熱して、エポキシ樹脂を硬化させた。

このようにして、空孔に樹脂を充填させたセラミック焼結体について、誘電率、透磁率、抗折強度及び吸水率を測定した。その結果を表 2 に示す。

【0062】

【表 2】

試料 No.	球状 ポリ マー 平均 粒径 (μm)	平均 空孔径 (μm)	空孔率 (vol%)	空孔に樹脂含浸			吸水率 (%)		抗折強度 (MPa)	
				誘電率 1MHz	複素透磁率		含浸 前	含浸 後	含浸 前	含浸 後
					1MHz	1GHz				
11	-	-	0	14.5	430	11	0.20	-	80	-
12	8	7	10	13.9	330	8.0	1.89	0.17	74	80
13	8	7	30	10.9	212	6.0	3.89	0.10	53	80
14	8	7	35	9.8	182	5.7	4.39	0.09	51	80
15	8	7	40	8.9	153	4.9	5.75	0.09	46	82
16	8	7	50	7.9	123	3.6	10.0	0.06	34	81
17	8	7	60	6.8	92	2.9	16.4	0.03	19	86
18	8	7	70	6.2	61	2.3	18.9	0.03	14	89
19	8	7	80	5.3	41	1.8	21.5	0.03	10	90

【0063】

表2より、セラミック焼結体の空孔にエポキシ樹脂を含浸（充填）させるようにした場合、試料番号11（表1の試料番号1と同じ）の空孔を含まないものと比べて、抗折強度を

同等又はそれ以上に向上させることが可能になることがわかる。
また、エポキシ樹脂の含浸を行ったものは、空孔率を80%とした場合（試料番号19）

【0064】

にも、空孔率を30%とし、エポキシ樹脂の含浸を行わないようにしたものより抗折強度

が大きいことがわかる。
また、吸水率に関しては、エポキシ樹脂を含浸させたものにおいては、吸水率が、試料番

号11の空孔を含まないものよりも低く安定することがわかる。

さらに、空孔比率が35vol%以上であれば、エポキシ樹脂を含浸させた場合にも、誘電率10以下を確保できることがわかる。

【0065】

なお、樹脂のほうが、ガラスに比べて誘電率の低いものを選択することが可能な場合があり、今回使用したエポキシ樹脂を用いた場合には、前記実施形態1のようにガラスを含浸

させた場合に比べて、いくらかではあるが、誘電率をさらに低下させることが可能になることがわかる。
＜2＞チップコイル部品の作製
(1) 上記＜1＞の表2、試料番号16の材料（すなわち、空孔率が50vol%のセラミック焼結体が得られる材料）を用いて形成したセラミックグリーンシートに、内部コイルを構成する電極となる銀ペーストを印刷し、積層、圧着した後、チップ形状にカットして900℃で焼成した。

これにより、焼成時に有機材料が焼失し空孔を50vol%の割合で含んだセラミック焼成体

(2) それから、セラミック焼結体のコイルの軸心方向に平行な両端側に内部電極と導通するように外部電極形成用の導電ペーストを塗布した後、850℃で熱処理することにより導電ペーストを焼成して外部電極を形成した。

(3) 次に、このチップを誘電率3.4のエポキシ系の液状樹脂中に含浸させた後、150℃で硬化させ、セラミック焼結体の空孔内にエポキシ樹脂を充填するとともにセラミック焼結体表面に樹脂膜を形成した。

(4) それから、樹脂を含浸させたチップをバレル研磨して、外部電極の金属表面をより確実に露出させた後、ニッケルめっき、及びSnめっきを行って、外部電極の表面にメッキ層を形成した。

これにより、長さ1.6mm、幅及び高さ0.8mmのチップコイル部品（実施例2）を得た。なお、この実施例2のチップコイル部品においては、コイルのターン数を30ターンとした。

【0066】

比較用のチップコイル部品として、上記実施形態1で作製した比較例1と同じのチップコイル部品（ターン数20）を用意した。

そして、この実施例2のチップコイル部品をネットワークアナライザHP8753Dに接続して反射特性を測定し、その結果からインピーダンスを算出した。図3に、実施例2及び比較例1のチップコイル部品のインピーダンス特性を示す。

【0067】

この実施例2のチップコイル部品においては、空孔を形成することにより、透磁率の特性を大きく損なうことなく誘電率を低下させた磁性体を用いているので、低周波領域では、従来と同様のインピーダンス特性を維持したまま、低誘電率化によって、高周波領域まで所望のインピーダンスを確保できることがわかる。

すなわち、比較例1のチップコイル部品では、600Ωのインピーダンスが得られる周波数は1.3GHz程度までであるが、実施例2のチップコイル部品では、600Ωのインピーダンスが得られる帯域が、約5GHzまで拡大していることがわかる。

【0068】

また、この実施例2のチップコイル部品においては、セラミック焼結体の空孔内部にエポキシ樹脂を含浸（充填）させるようにしているので、従来の空孔を含まないフェライト材を用いた比較例1のチップコイル部品と比べて抗折強度に遜色がなく、また、吸水率に関しては、比較例1のチップコイル部品よりも低くなっており、信頼性の面でも比較例1より優れていることが確認されている。

【0069】

【実施形態3】

(1) 上記実施形態1及び2と同様の方法で、空孔率が60vol%の多孔質フェライト（セラミック焼結体）を作製した。

(2) それから、この多孔質フェライトを、誘電率3.4のエポキシ樹脂を、粘度が300mPa・s、及び500mPa・sになるように有機溶剤で希釈した溶剤中に浸漬してエポキシ樹脂を含浸（充填）させた後、150℃で30分加熱してエポキシ樹脂を硬化させた。

【0070】

そして、このようにして得た、エポキシ樹脂の含浸、硬化後の多孔質フェライトについて、空孔率、誘電率、及び抗折強度を測定した。

なお、誘電率が8.4で、粘度が500mPa・sの無溶剤タイプのエポキシ樹脂を含浸させ、同様に硬化させた試料について、空孔率、誘電率、及び抗折強度を測定した。その結果を表3に示す。

【0071】

【表3】

含浸材	空孔率 (vol%)	誘電率	抗折強度 (Mpa)
含浸前	60	6.6	20
粘度300mPa.s エポキシ含浸後	58	6.8	120
粘度500mPa.s エポキシ含浸後	57	6.9	131
粘度5000mPa.s エポキシ含浸後	27	8.4	130

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【0072】

粘度が500mPa.s以下のエポキシ樹脂を用いた場合、含浸（充填）させたエポキシ樹脂にも空孔が形成され、高強度で、さらに低誘電率の多孔質フェライトが得られることがわかる。

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これは、多孔質フェライトの空孔内に充填させたエポキシ樹脂中の希釈剤が揮発して、エポキシ樹脂の内部にも空孔が形成されたことによるものである。

なお、多孔質フェライトの空孔内に充填された樹脂やガラスに空孔を形成する方法としては、上記の方法の他に、例えば、一旦粘度の高い樹脂やガラス原料を含浸させた後、溶剤内で超音波洗浄などを行ない、含浸させた樹脂やガラス原料の基材の一部を溶出させた後、溶剤を揮発させ、硬化する方法などを適用することが可能である。

【0073】

[実施形態4]

図4及び5は、本願発明の実施形態にかかるセラミック電子部品（T型LCフィルタ）を示す図であり、図4はその構成を示す分解斜視図、図5は模式的な断面図である。

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この実施形態4のセラミック電子部品11は、インダクタ部（コイル部）12と13の間にコンデンサ部14が配設された構造を有するT型LCフィルタ（積層型LCフィルタ）である。

【0074】

このT型LCフィルタにおいて、インダクタ部12は、コイル導体35a、35b、35c及び中継用ビアホール36a、36b、36cを設けた磁性体層22、引出し用ビアホール37aを設けた磁性体層22、引出し用導体38aを設けた磁性体層22などから構成されており、コイル導体35a～35cは、中継用ビアホール36b、36cを介して接続されることによりコイル26を形成している。

【0075】

また、インダクタ部13は、コイル導体35d、35e、35f及び中継用ビアホール36d、36e、36fを設けた磁性体層22、引出し用ビアホール37bを設けた磁性体層22、引出し用導体38b及び引出し用ビアホール37cを設けた磁性体層22などから構成されており、コイル導体35d～35fは、中継用ビアホール36e、36fを介して接続されることによりコイル27を形成している。

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【0076】

また、コンデンサ部14は、グラウンド電極30、スルー電極31、スルー電極連結用ビアホール41b、42aを設けた誘電体層23、及びスルー電極連結用ビアホール41a、41c、42bを設けた誘電体層23などを備えており、互いに対向するように配設されたグラウンド電極30とスルー電極31から、コンデンサ33が形成されている。

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【0077】

そして、磁性体層22と、誘電体層23を積み重ね、一体に焼結することにより形成されたセラミック焼結体の両端部には、図5に示すように、入力用の外部電極51及び出力用の外部電極52が配設され、セラミック焼結体の中央部には接地用の外部電極53が配設されている。

【0078】

この実施形態4のT型LCフィルタにおいては、インダクタ部12, 13を構成する磁性体層の構成材料として、実施形態1〜3でその製造方法を説明した空孔を有するフェライト材料が用いられており、コンデンサ部14には誘電体セラミック材料が用いられている。

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【0079】

このT型LCフィルタにおいては、インダクタ部12, 13を構成する磁性体層の構成材料として、空孔を有する誘電率の低いフェライト材料が用いられていることから、高周波でのノイズ減衰特性の優れたフィルタを得ることができる。

また、このT型フィルタは、磁性体材料として用いられている空孔を含むフェライト材料は、空孔内に充填された樹脂やガラスなどにより補強され、優れた抗折強度を有していることから、十分な信頼性を備えている。

【0080】

なお、この実施形態4では、T型LCフィルタを例にとりて説明したが、本願発明のフェライト材料を用いたインダクタ部と抵抗部を組み合わせたLR複合電子部品、インダクタ部とコンデンサ部と抵抗部とを組み合わせたLCR複合電子部品などを製造することも可能である。

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【0081】

なお、上記の各実施形態では、焼失材として、架橋ポリスチレンからなる焼失材を用いた場合について説明したが、その他の焼失性の材料からなる焼失材を用いることも可能である。

また、上記の実施形態では、焼失材として、球状の焼失材を用いているが、球状のものに限らず、粉粒体状の焼失材を用いることも可能である。

【0082】

また、上記実施形態では、セラミック焼結体を構成する材料が、Ni-Zn-Cu系フェライト材料である場合を例にとりて説明したが、他のフェライト材料を用いる場合や、フェライト以外の材料を用いる場合にも本願発明を適用することが可能である。

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【0083】

本願発明は、さらにその他の点においても、上記実施形態に限定されるものではなく、セラミック焼結体の空孔に充填させる樹脂又はガラスの種類、樹脂又はガラスを充填させる方法、焼失材を焼失させるための焼成条件などに関し、発明の範囲内において、種々の応用、変形を加えることが可能である。

【0084】

【発明の効果】

上述のように、本願発明（請求項1）のセラミック電子部品は、セラミック焼結体に35〜80vol%の割合で空孔を含ませるとともに、その空孔に樹脂又はガラスを充填させているので、セラミック焼結体の強度低下を招くことなく誘電率を低下させることが可能になり、浮遊容量の発生を抑制することが可能になる。

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すなわち、セラミック焼結体に35〜80vol%の割合で空孔を含ませるようにしているので、セラミック焼結体のセラミックグレインの連続性（特に磁性体セラミックの場合は磁路の連続性）を確保して、セラミック焼結体の電気特性（特に磁性体セラミックの場合は磁性特性）を大きく低下させることなく、セラミック焼結体の誘電率を大幅に低下させることが可能になる。一方、セラミック焼結体の空孔には樹脂又はガラスを充填しているので、セラミック焼結体の強度を確保することが可能になる。したがって、高周波領域におけるインピーダンス特性に優れ、かつ、機械的強度が大きくて信頼性の高いセラミッ

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ク電子部品を得ることが可能になる。

【0085】

また、請求項2のセラミック電子部品は、セラミック焼結体が、セラミック原料と、バインダーと、球状又は粉粒体状でバインダーに対する接着性を有する焼失材とを配合した配合セラミック原料の成形体を焼成することにより形成されており、特にセラミック焼結体が磁性体セラミックの場合、磁路を分断しない程度の35～80vol%の空孔を含有していることから、所望の磁性特性を備え、浮遊容量の発生が少なく、所望の特性を備えた信頼性の高いセラミック電子部品を提供することができるようになる。

【0086】

また、請求項3のセラミック電子部品のように、前記空孔に充填された樹脂又はガラス中に、さらに空孔を含ませることにより、セラミック焼結体の誘電率をさらに低下させることが可能になり、本願発明をさらに実効あらしめることができる。

【0087】

また、セラミック焼結体を構成するセラミック原料として磁性体セラミックが用いられる場合に、請求項4のように、本願発明を適用することにより、セラミック焼結体の機械的な強度の低下を招くことなく、誘電率を低下させて浮遊容量の発生を抑制することが可能になり、所望の特性を備えた信頼性の高いセラミック電子部品（インダクタなど）を提供することが可能になる。

【0088】

また、本願発明は、請求項5のように、インダクタ、LC複合電子部品、LR複合電子部品又はLCR複合電子部品などの種々のセラミック電子部品に適用することが可能であり、セラミック焼結体の強度が大きくて、浮遊容量の発生が少ない、所望の特性を備えた電子部品を提供することができる。

【0089】

また、本願発明は、請求項6のように、複数のセラミック層間に電極層を配した積層構造を有し、セラミック焼結体の抗折強度などが問題になりやすい積層セラミック電子部品に好適に適用することが可能であり、本願発明を適用することにより、誘電率の低いセラミック層を積層してなり、かつ、機械的強度が大きくて信頼性の高い積層セラミック電子部品を得ることが可能になる。

【0090】

また、請求項7のセラミック電子部品のように、空孔の平均径を5～20 μ mとすることにより、空孔内に樹脂又はガラスを十分に充填させることが可能になるとともに、空孔が形成された磁性体の強度の低下を防止することが可能になり、信頼性の高い積層セラミック電子部品を得ることが可能になる。

【0091】

また、請求項8のセラミック電子部品のように、セラミック焼結体の表面を樹脂又はガラスで覆うことにより、セラミック焼結体の強度をさらに向上させることが可能になる。なお、樹脂又はガラスとして、空孔内に充填した樹脂又はガラスと同じ樹脂又はガラスを用いることにより、製造工程の複雑化を招くことを防止することができる。

【0092】

また、本願発明（請求項9）のセラミック電子部品の製造方法は、セラミック原料と、バインダーと、球状又は粉粒体状で、バインダーに対する接着性を有する焼失材とを配合したセラミック焼結体用の配合セラミック原料を用いて、内部に電極（電極材料）が配設された成形体を形成し、この成形体を焼成することにより35～80vol%の空孔を含むセラミック焼結体を形成した後、セラミック焼結体の前記空孔に樹脂又はガラスを充填させるようにしているので、セラミック焼結体中のセラミックグレインの連続性を確保しつつ、セラミック焼結体に空孔を形成して、セラミック焼結体の各種電気特性を大きく低下させることなく、セラミック焼結体の誘電率を大幅に低下させることが可能になるとともに、空孔中に充填させた樹脂又はガラスにより、セラミック焼結体の強度を向上させることが可能になり、所望の特性を備えた信頼性の高いセラミック電子部品を効率よく製造す

ることができる。

【0093】

また、請求項10のセラミック電子部品の製造方法のように、セラミック原料に配合される焼失材として、架橋ポリスチレン、架橋ポリメタクリル酸メチル、架橋ポリメタクリル酸ブチル、架橋ポリメタクリル酸エステル、架橋ポリアクリル酸エステルからなる群より選ばれる少なくとも1種を主成分とするものを用いた場合、焼成工程で、セラミック焼結体に確実に空孔を形成することが可能になり、所望の空孔率を有するセラミック焼結体を効率よく形成することが可能になる。

【0094】

また、請求項11のセラミック電子部品の製造方法のように、セラミック焼結体の空孔に樹脂又はガラスを充填させる工程において、樹脂又はガラスとして、溶剤又は希釈剤を配合した樹脂又はガラスを用い、空孔に樹脂又はガラスを充填した後に、溶剤又は希釈剤を揮発させるようにした場合、樹脂又はガラス中に、さらに空孔を形成することが可能になり、セラミック焼結体の誘電率をさらに低下させることができるようになる。

【0095】

また、請求項12のセラミック電子部品の製造方法のように、セラミック焼結体の空孔に樹脂又はガラスを充填させる工程において、樹脂又はガラスとして、溶剤により一部を溶出させることができる樹脂又はガラスを用い、該樹脂又はガラスを充填した後に、溶剤により樹脂又はガラスの一部を溶出させるようにした場合、セラミック焼結体の空孔に充填させた樹脂又はガラスの一部を除去して、セラミック焼結体の誘電率をさらに低下させることが可能になり、本願発明をさらに実効あらしめることができる。

【0096】

また、インダクタのように、セラミック焼結体を構成するセラミックとして磁性体セラミックが用いられる場合に、請求項13のように、本願発明を適用することにより、セラミック焼結体の強度低下を招くことなく、誘電率を低下させて浮遊容量の発生を抑制することが可能になり、所望のインピーダンス特性を備えた信頼性の高いセラミック電子部品を得ることができるようになる。

【0097】

また、請求項14のセラミック電子部品の製造方法のように、本願発明のセラミック電子部品の製造方法は、インダクタ、LC複合電子部品、LR複合電子部品、LCR複合電子部品などの種々の電子部品を製造する場合に適用することが可能であり、セラミック焼結体の強度低下を招くことなく、誘電率を低下させ、浮遊容量が小さく、所望のインピーダンス特性を備えた信頼性の高いインダクタ、LC複合電子部品、LR複合電子部品、LCR複合電子部品などを効率よく製造することができるようになる。

【0098】

また、請求項15のセラミック電子部品の製造方法のように、本願発明のセラミック電子部品の製造方法は、複数のセラミック層間に電極層を配した積層構造を有し、セラミック焼結体の抗折強度などが問題になりやすい積層セラミック電子部品を製造する場合に好適に適用することが可能であり、本願発明を適用することにより、インピーダンス特性に優れ、かつ、機械的強度が大きくて信頼性の高い積層セラミック電子部品を効率よく製造することが可能になる。

【図面の簡単な説明】

【図1】本願発明の一実施形態にかかるチップコイル部品を示す断面図である。

【図2】本願発明の一実施形態（実施形態1）にかかるチップコイル部品（実施例1）のインピーダンス特性を示す図である。

【図3】本願発明の他の実施形態（実施形態2）にかかるチップコイル部品（実施例2）のインピーダンス特性を示す図である。

【図4】本願発明の他の実施形態（実施形態4）にかかるセラミック電子部品（T型LCフィルタ）の構成を示す分解斜視図である。

【図5】本願発明の他の実施形態（実施形態4）にかかるセラミック電子部品（T型LC

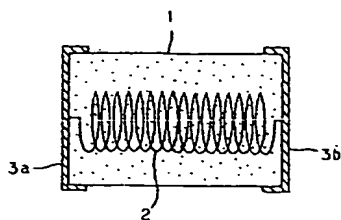
フィルタ)の構成を模式的に示す断面図である。

【図6】本願発明のセラミック電子部品におけるセラミック焼結体の一部を模式的に示す断面図である。

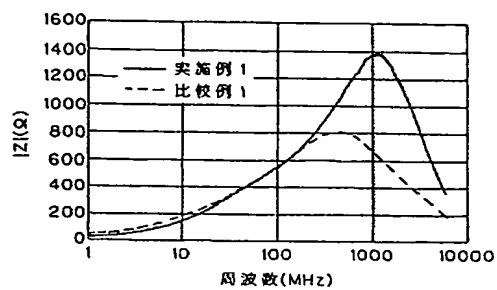
【符号の説明】

- | | | |
|--|----------------------|----|
| 1 | セラミック焼結体 | |
| 2 | コイル | |
| 3 a, 3 b | 外部電極 | |
| 1 1 | セラミック電子部品 (T型LCフィルタ) | |
| 1 2, 1 3 | インダクタ部 (コイル部) | |
| 1 4 | コンデンサ部 | 10 |
| 2 2 | 磁性体層 | |
| 2 3 | 誘電体層 | |
| 2 6, 2 7 | コイル | |
| 3 0 | グランド電極 | |
| 3 1 | スルー電極 | |
| 3 3 | コンデンサ | |
| 3 5 a, 3 5 b, 3 5 c, 3 5 d, 3 5 e, 3 5 f | コイル導体 | |
| 3 6 a, 3 6 b, 3 6 c, 3 6 d, 3 6 e, 3 6 f | 中継用ビアホール | |
| 3 7 a, 3 7 b, 3 7 c | 引出し用ビアホール | |
| 3 8 a, 3 8 b | 引出し用導体 | 20 |
| 4 1 b, 4 2 a | スルー電極連結用ビアホール | |
| 4 1 a, 4 1 c, 4 2 b | スルー電極連結用ビアホール | |
| 5 1 | 入力用の外部電極 | |
| 5 2 | 出力用の外部電極 | |
| 5 3 | 接地用の外部電極 | |
| 6 1 | セラミック焼結体 | |
| 6 2 | 空孔 | |
| 6 3 | 樹脂又はガラス | |
| 6 4 | 空孔 | |

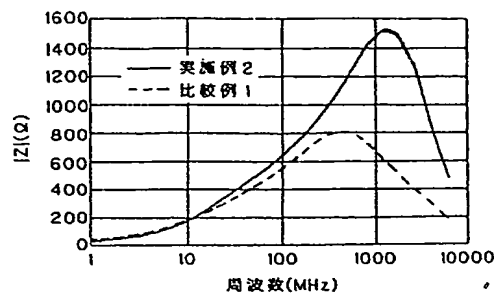
【図 1】



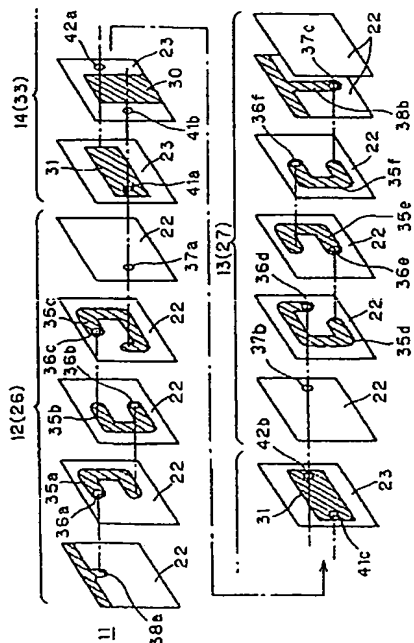
【図 2】



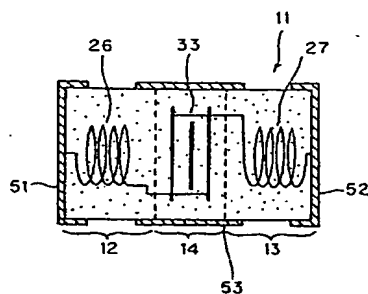
【図 3】



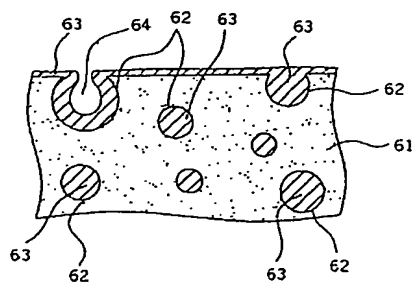
【図 4】



【図 5】



【図 6】



フロントページの続き

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[Theme code (reference)]

5E070

[F term (reference)]

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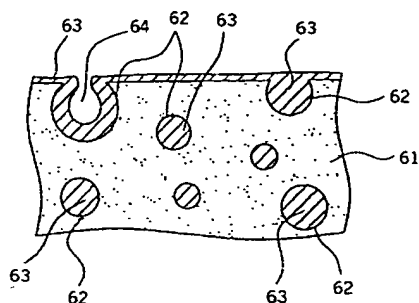
(57) [Abstract]

[Technical problem] The dielectric constant of a ceramic sintered compact is low, it excels in the impedance characteristic in a GHz band, and the ceramic electronic parts which can obtain a high impedance characteristic in a large frequency range, and its manufacture approach are offered.

[Means for Solution] A ceramic raw material, a binder, and spherical or the combination ceramic raw material which blended the destruction-by-fire material which has an adhesive property over a binder by the shape of a particulate matter is used. After forming the Plastic solid which has the structure where the electrode was arranged in the interior and forming the ceramic sintered compact which includes a 35 - 80vol% hole by calcinating this Plastic solid, by making a ceramic sintered compact fill up with resin or glass Without causing the fall of a ceramic sintered compact on the strength, a dielectric constant is reduced and generating of stray capacity is controlled.

[Selection Fig.] drawing 6

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CLAIMS

[Claim(s)]

[Claim 1]

The ceramic sintered compact which includes a hole at a 35 - 80vol% rate, The electrode arranged in the interior of said ceramic sintered compact, It **** and said hole of said ceramic sintered compact is filled up with resin or glass.

Ceramic electronic parts by which it is characterized.

[Claim 2]

That said ceramic sintered compact is as spherical as a ceramic raw material and a binder, or ceramic electronic parts according to claim 1 characterized by forming a 35 - 80vol% hole by calcinating the Plastic solid of the combination ceramic raw material which comes to blend the destruction-by-fire material which has an adhesive property over said binder by the shape of a particulate matter.

[Claim 3]

Ceramic electronic parts according to claim 1 or 2 characterized by

including the hole further in the resin with which said hole was filled up, or glass.

[Claim 4]

Ceramic electronic parts according to claim 1 to 3 characterized by the ceramic which constitutes said ceramic sintered compact being a magnetic-substance ceramic.

[Claim 5]

Said ceramic electronic parts are ceramic electronic parts according to claim 1 to 4 characterized by being LC compound electronic parts which combined an inductor, the inductor section, and the capacitor section, LR compound electronic parts which combined the inductor section and resistance, or the LCR compound electronic parts which combined the inductor section, the capacitor section, and resistance.

[Claim 6]

Ceramic electronic parts according to claim 1 to 5 characterized by being the laminating ceramic electronic parts which have the laminated structure which allotted the electrode layer among two or more ceramic layers.

[Claim 7]

Ceramic electronic parts according to claim 1 to 6 characterized by the pitch diameter of said hole being 5-20 micrometers.

[Claim 8]

Ceramic electronic parts according to claim 1 to 7 characterized by covering the front face of said ceramic sintered compact with said resin or glass.

[Claim 9]

It is the manufacture approach of ceramic electronic parts of having the structure where the electrode was arranged in the interior of a ceramic sintered compact,

A ceramic raw material, a binder, and spherical or the process which forms the Plastic solid with which the electrode was arranged in the interior by the shape of a particulate matter using the combination ceramic raw material which blended the destruction-by-fire material which has an adhesive property over said binder,

The process which forms the ceramic sintered compact with which the electrode was arranged in the interior by calcinating said Plastic solid, including a 35 - 80vol% hole,

The process which makes said hole of said ceramic sintered compact fill up with resin or glass

The manufacture approach of the ceramic electronic parts characterized by providing.

[Claim 10]

The manufacture approach of the ceramic electronic parts according to claim 9 characterized by being that to which said destruction-by-fire material uses as a principal component at least one sort chosen from the group which consists of bridge formation polystyrene, a bridge formation polymethyl methacrylate, bridge formation polymethacrylic acid butyl, bridge formation polymethacrylic acid ester, and bridge formation polyacrylic ester.

[Claim 11]

In the process which makes said hole of said ceramic sintered compact fill up with resin or glass,

After filling up said hole with resin or glass as said resin or glass using the resin or glass which blended the solvent or the diluent, a hole is further formed into resin or glass by volatilizing said solvent or diluent.

The manufacture approach of the ceramic electronic parts according to claim 9 or 10 by which it is characterized.

[Claim 12]

In the process which makes said hole of said ceramic sintered compact fill up with resin or glass By carrying out elution of some of resin or glass with a solvent, and removing, after filling up said hole with this resin or glass as said resin or glass using the resin or glass to which elution of the part can be carried out with a solvent The manufacture approach of the ceramic electronic parts according to claim 9 to 11 characterized by forming a hole further into said resin or glass.

[Claim 13]

The manufacture approach of the ceramic electronic parts according to claim 9 to 12 characterized by using a magnetic-substance ceramic raw material as said ceramic raw material.

[Claim 14]

The manufacture approach of the ceramic electronic parts according to claim 9 to 13 characterized by being what used in order to manufacture LC compound electronic parts which combined an inductor, the inductor section, and the capacitor section, LR compound electronic parts which combined the inductor section and resistance, or the LCR compound electronic parts which combined the inductor section, the capacitor section, and resistance.

[Claim 15]

The manufacture approach of the ceramic electronic parts according to claim 9 to 14 characterized by producing by carrying out two or more laminatings of the ceramic green sheet which forms an electrode layer on

the ceramic green sheet which consists said Plastic solid of said combination ceramic raw material, and has an electrode layer.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]

About ceramic electronic parts and its manufacture approach, in detail, the invention in this application is excellent in the impedance characteristic in high frequency bands, such as a GHz band, and relates to ceramic electronic parts and its manufacture approaches, such as an inductor which can obtain a high impedance in a large frequency range.

[0002]

[Description of the Prior Art]

In recent years, RF-ization of electronic equipment progresses and that to which an inductor, LC composite part, LR composite part, LCR composite part, etc. can respond to the RF of a GHz band is called for.

[0003]

However, in the inductor for high frequency bands, the stray capacity generated in a coil and parallel influences the impedance greatly, and has effect to an impedance with especially big $1/100\text{pF}$ -1 / minute stray capacity of about 10pF with a GHz band on it. Therefore, when stray capacity tends to be made small and it is going to secure a desired property, it is necessary to lower the dielectric constants epsilon, such as a ferrite used as the magnetic substance. However, since a ferrite is structural, it is difficult to lower the dielectric constant epsilon of the ferrite itself to 13 to 14 or less as a matter of fact.

[0004]

If it is going to lower a dielectric constant ϵ under such circumstances, how to blend an ingredient with the low dielectric constant of resin, glass, etc. with the magnetic substance can be considered, but in the composite magnetic material which blended with the magnetic substance the resin which is non-magnetic material, glass, etc., since a magnetic-substance particle will be covered with non-magnetic-material ingredients, such as resin and glass, and a magnetic path will be divided, there is a trouble that permeability will become extremely low.

[0005]

Moreover, the foaming ferrite sintered compact which made the void content 20 - 70% is known in recent years as a ferrite ingredient with a low dielectric constant used for a wave absorber etc. (for example, patent reference 1 reference). Since this ferrite sintered compact includes the hole at a high rate, its dielectric constant is low, and since the magnetic path is continuing, it has the description of not changing an electromagnetic property sharply discontinuously. That is, since each ferrite particles are magnetically combined even if, as for this foaming ferrite sintered compact, a void content becomes high, fluctuation of the frequency dispersion property of ferrite complex permeability which is seen in the case of the mixed ferrite of ferrite powder and an insulating material has the description of being few.

[0006]

Moreover, it has the internal electrode formed in the interior of a ceramic and a ceramic as electronic parts using the ceramic which made the hole contain, and the ceramic electronic parts which made the ceramic contain a hole (pore) with a diameter of 1-3 micrometers at a rate of 3 - 30 volume % are proposed (for example, patent reference 2 reference).

[0007]

since 3 - 30 volume % appears in a ceramic comparatively and he is trying for these ceramic electronic parts to make it contain pore with a diameter of 1-3 micrometers, they have the description of becoming possible to lower the dielectric constant of a ceramic and becoming possible to raise an impedance characteristic so much.

[0008]

[Patent reference 1]

JP, 55-526300, A

[Patent reference 2]

JP, 11-67575, A

[0009]

[Problem(s) to be Solved by the Invention]

However, in the foaming ferrite sintered compact of the patent reference 1, since the mechanical strength of a Plastic solid will fall if it is going to make a void content high, the way things stand, there is a trouble that it is difficult to secure required anti-chip box reinforcement as an electronic-parts ingredient.

[0010]

Moreover, in the ceramic electronic parts of the patent reference 2, since the content rate of pore is made into the range of 3 - 30 volume % in consideration of the anti-chip box reinforcement of a ceramic element assembly falling if the content rate of pore exceeds 30 volume %, the actual condition cannot necessarily fill the demand to the ceramic electronic parts which the range of reduction of specific inductive capacity was restrained, and were equipped with the still higher property in recent years fully.

[0011]

Moreover, since moisture tends to enter the hole included in a ceramic and water absorption becomes high, there is a trouble that dependability falls in the ceramic electronic parts of the patent reference 2.

[0012]

The invention in this application solves the above-mentioned trouble, and its dielectric constant is low and it aims at offering ceramic electronic parts equipped with the ceramic sintered compact of high intensity, and its manufacture approach.

[0013]

[Means for Solving the Problem]

In order to attain the above-mentioned purpose, they are the ceramic electronic parts of the invention in this application (claim 1), The ceramic sintered compact which includes a hole at a 35 - 80vol% rate, The electrode arranged in the interior of said ceramic sintered compact, It **** and said hole of said ceramic sintered compact is filled up with resin or glass.

It is considering as the description.

[0014]

It becomes possible to reduce the dielectric constant, without according to the ceramic electronic parts of the invention in this application (claim 1), causing the fall of a ceramic sintered compact on the strength, since the hole of a ceramic sintered compact is filled up with resin or glass while a ceramic sintered compact includes a hole at a 35 - 80vol% rate.

[0015]

Namely, it sets to the ceramic electronic parts of the invention in this application (claim 1). By including a hole in a ceramic sintered compact at a 35 - 80vol% rate Without securing the continuity of the ceramic grain in a ceramic sintered compact, and reducing the various electrical properties of a ceramic sintered compact Since said hole of a ceramic sintered compact is filled up with resin or glass while becoming possible to reduce the dielectric constant of a ceramic sintered compact sharply It becomes possible to secure the reinforcement of a ceramic sintered compact, and it becomes possible to excel in various kinds of electrical properties, and to obtain ceramic electronic parts with high dependability with a large mechanical strength.

[0016]

In addition, paying attention to being weak to tensile stress, although ceramic ingredients, such as a ferrite, are strong to compressive stress, even if the invention in this application is a minute amount According to the invention in this application, using the ability to reinforce tension proof stress by making it filled up with resin or glass in a hole It becomes possible to lower especially a dielectric constant to six or less, without becoming possible to raise a void content even to 80%, and causing degradation of an electrical property, securing bigger mechanical strengths (anti-chip box reinforcement etc.) than what made the conventional void content 30vol(s)%.

[0017]

Moreover, in the ceramic electronic parts of the invention in this application, when a ceramic sintered compact is a magnetic-substance ceramic, since he is trying to include a hole in a ceramic sintered compact, some permeability of the magnetic substance also falls. However, since the continuous magnetic path is formed in the magnetic-substance ceramic, it becomes possible to maintain the property of the permeability which the magnetic substance has (that is, the cross point frequency from which μ' and μ'' become the same value hardly changes).

[0018]

Moreover, the volume fraction (void content) of a hole needs to carry out to more than 35vol% from the standpoint which the dielectric constant of a ceramic sintered compact is fully reduced, and secures a desired property. Moreover, if a void content exceeds 80vol(s)%, since the reinforcement after baking will fall and restoration by approaches, such as subsequent resin and glass sinking-in processing, will become difficult, to consider as less than [80vol%] is required.

In addition, in the invention in this application, it is desirable to make a void content into the range of 40 - 50vol%.

In addition, since the function in which the resin or glass with which it filled up in the hole compensates the reinforcement of a ceramic sintered compact is achieved, processing is possible, if there is especially no problem, the diameter of a hole is 5-20 micrometers and the void content of a ceramic sintered compact is the range to 80vol(s)%, even if some reinforcement of the ceramic sintered compact after hole formation is weak.

[0019]

Moreover, the ceramic electronic parts of claim 2 are characterized by that said ceramic sintered compact is as spherical as a ceramic raw material and a binder, or forming a 35 - 80vol% hole by calcinating the Plastic solid of the combination ceramic raw material which comes to blend the destruction-by-fire material which has an adhesive property over a binder by the shape of a particulate matter.

[0020]

A ceramic sintered compact the ceramic electronic parts of claim 2 A ceramic raw material, It is formed [calcinate / spherical or / a binder and / the Plastic solid of the combination ceramic raw material which blended the destruction-by-fire material which has an adhesive property over a binder by the shape of a particulate matter]. From containing the with an extent [35 - 80vol% of] which does not divide a magnetic path hole, when especially a ceramic sintered compact is a magnetic-substance ceramic It has desired magnetic property, and there can be little generating of stray capacity and ceramic electronic parts with the high dependability equipped with the desired property can be offered now.

[0021]

Moreover, the ceramic electronic parts of claim 3 are characterized by including a hole further in the resin with which said hole was filled up, or glass.

[0022]

reducing the dielectric constant of a ceramic sintered compact further by including a hole further into the resin with which said hole was filled up, or glass -- possible -- becoming -- the invention in this application -- further -- efficiency -- oh, it can close.

[0023]

Moreover, the ceramic electronic parts of claim 4 are characterized by the ceramic which constitutes said ceramic sintered compact being a magnetic-substance ceramic.

[0024]

Without causing the fall of the mechanical reinforcement of a ceramic

sintered compact by applying the invention in this application in such a case, although a magnetic-substance ceramic is used as a ceramic raw material which constitutes a ceramic sintered compact when manufacturing an inductor etc., it becomes possible to reduce a dielectric constant and to control generating of stray capacity, and it becomes possible to offer ceramic electronic parts with the high dependability equipped with the desired property (inductor etc.).

[0025]

Moreover, the ceramic electronic parts of claim 5 are characterized by being LC compound electronic parts which combined an inductor, the inductor section, and the capacitor section, LR compound electronic parts which combined the inductor section and resistance, or the LCR compound electronic parts which combined the inductor section, the capacitor section, and resistance.

[0026]

That is, the invention in this application can be applied to various ceramic electronic parts, such as an inductor, LC compound electronic parts, LR compound electronic parts, or LCR compound electronic parts, and it becomes possible to offer the electronic parts with which the reinforcement of a ceramic sintered compact was large with electronic parts and generating of stray capacity was equipped with few desired properties.

[0027]

Moreover, the ceramic electronic parts of claim 6 are characterized by being the laminating ceramic electronic parts which have the laminated structure which allotted the electrode layer among two or more ceramic layers.

[0028]

That is, it is possible to apply suitable for the laminating ceramic electronic parts with which the invention in this application has the laminated structure which allotted the electrode layer among two or more ceramic layers, and the anti-chip box reinforcement of a ceramic sintered compact etc. tends to become a problem, and it enables a mechanical strength to come to carry out the laminating of the ceramic layer with a low dielectric constant, and to offer large and reliable laminating ceramic electronic parts by applying the invention in this application.

[0029]

Moreover, the ceramic electronic parts of claim 7 are characterized by the pitch diameter of said hole being 5-20 micrometers.

[0030]

Although it is desirable in the invention in this application to be referred to as 5-20 micrometers as for the dimension (diameter of a hole) of the hole of a ceramic sintered compact, this is easy to become a closed hole and it becomes impossible to make it fully filled up with resin or glass in a hole, when the diameter of a hole is set to 5 micrometers or less, and the diameter of a hole exceeds 20 micrometers, it will be because the reinforcement of the magnetic substance itself in which the hole after baking was formed becomes weak and processing becomes difficult. In addition, as for the pitch diameter of this hole, it is still more desirable to consider as the range of 5-10 micrometers.

[0031]

Moreover, the ceramic electronic parts of claim 8 are characterized by covering the front face of said ceramic sintered compact with said resin or glass.

[0032]

In the ceramic electronic parts of the invention in this application, although especially the thing for which all the front faces of a ceramic sintered compact are covered with resin or glass is desirable, it is also possible to consider as the configuration with which only the part was covered among front faces. Thereby, the reinforcement of a ceramic sintered compact can be raised further.

[0033]

Moreover, the manufacture approach of the ceramic electronic parts of claim 9,

It is the manufacture approach of ceramic electronic parts of having the structure where the electrode was arranged in the interior of a ceramic sintered compact,

A ceramic raw material, a binder, and spherical or the process which forms the Plastic solid with which the electrode was arranged in the interior by the shape of a particulate matter using the combination ceramic raw material which blended the destruction-by-fire material which has an adhesive property over said binder,

The process which forms the ceramic sintered compact with which the electrode was arranged in the interior by calcinating said Plastic solid, including a 35 - 80vol% hole,

The process which makes said hole of said ceramic sintered compact fill up with resin or glass

It is characterized by providing.

[0034]

The manufacture approach of the ceramic electronic parts of the invention in this application A ceramic raw material, a binder, and the

combination ceramic raw material spherical or for the ceramic sintered compacts which blended the destruction-by-fire material which has an adhesive property over a binder by the shape of a particulate matter are used. After forming the Plastic solid with which the electrode (electrode material) was arranged in the interior and forming the ceramic sintered compact which includes a 35 - 80vol% hole by calcinating this Plastic solid, Since he is trying to make the hole of a ceramic sintered compact fill up with resin or glass A hole is formed in a ceramic sintered compact, securing the continuity of the ceramic grain in a ceramic sintered compact. While becoming possible to reduce the dielectric constant of a ceramic sintered compact sharply, without reducing the various electrical properties of a ceramic sintered compact greatly The resin or glass with which you made it filled up all over a hole enables it to raise the reinforcement of a ceramic sintered compact, and it becomes possible to manufacture efficiently ceramic electronic parts with the high dependability equipped with the desired property. Moreover, in the invention in this application, as destruction-by-fire material, although it is possible to use anything of a particulate matter-like gestalt, it is more desirable from standpoints of distribution, such as homogeneity, spherical or to use a spherical thing. Moreover, it is desirable to use for a ceramic sintered compact that whose mean particle diameter is 5-20 micrometers as destruction-by-fire material from the standpoint which forms the hole whose diameter of a hole is 5-20 micrometers.

Moreover, it is desirable to blend at a rate to which destruction-by-fire material usually becomes 35 - 80vol% from the standpoint which realizes a desired void content in said combination ceramic raw material, and it is desirable to blend so that it may become 40 - 50vol% especially. In addition, destruction-by-fire material can be suitably blended according to a target void content.

[0035]

Moreover, the manufacture approach of the ceramic electronic parts of claim 10 is characterized by being that to which the destruction-by-fire material blended with said ceramic raw material uses as a principal component at least one sort chosen from the group which consists of bridge formation polystyrene, a bridge formation polymethyl methacrylate, bridge formation polymethacrylic acid butyl, bridge formation polymethacrylic acid ester, and bridge formation polyacrylic ester.

[0036]

When what uses as a principal component at least one sort chosen from the group which consists of bridge formation polystyrene, a bridge

formation polymethyl methacrylate, bridge formation polymethacrylic acid butyl, bridge formation polymethacrylic acid ester, and bridge formation polyacrylic ester as destruction-by-fire material blended with a ceramic raw material is used, destruction-by-fire material is certainly burned down by the baking process, it becomes possible to form a hole in a ceramic sintered compact certainly, and it becomes possible to form efficiently the ceramic sintered compact which has a desired void content.

[0037]

In addition, in order to increase destruction-by-fire material sharply, increasing the rate of destruction-by-fire material and securing the rate of a ceramic, in order to increase a void content sharply, it is necessary to reduce the rate of a binder, but when the rate of a binder is reduced, there is an inclination for the reinforcement of the half-finished products before sintering to fall, and for the yield in a processing process to fall. However, without reducing the yield, when surface area is greatly excellent in the adhesive property over a resin binder and adopts the large crosslinked polymer of firmness as destruction-by-fire material, it becomes possible to reduce the rate of a binder and to increase the rate of destruction-by-fire material, and it becomes possible to raise a void content.

[0038]

Moreover, the manufacture approach of the ceramic electronic parts of claim 11,

In the process which makes the hole of a ceramic sintered compact fill up with resin or glass,

After filling up a hole with resin or glass as resin or glass using the resin or glass which blended the solvent or the diluent, a hole is further formed in resin or glass by volatilizing a solvent or a diluent. It is considering as the description.

[0039]

In the process which makes the hole of a ceramic sintered compact fill up with resin or glass, after being filled up with resin or glass as resin or glass using the resin or glass which blended the solvent or the diluent, by volatilizing a solvent or a diluent, it becomes possible to form a hole further into resin or glass, and it becomes possible to reduce the dielectric constant of a ceramic sintered compact further.

[0040]

In addition, as a solvent or dilution material, it is possible to, use ethanol, a xylene, butyl acetate, water, etc. for example.

Moreover, as for a solvent or a diluent, it is desirable to be a volume

ratio and to blend in 5-50 to resin or glass 100. If the blending ratio of coal becomes less than five by the volume ratio to resin or glass 100, the effectiveness of the viscosity reduction after dilution is inadequate, workability falls, and if 50 is exceeded, dilution material will remain in the interior of resin at the time of resin hardening, and this is because the property of resin deteriorates.

[0041]

Moreover, in the process which makes said ceramic sintered compact fill up with resin or glass, after the manufacture approach of the ceramic electronic parts of claim 12 is filled up with this resin or glass as resin or glass using the resin or glass to which elution of the part can be carried out with a solvent, it is characterized by carrying out elution of some of resin or glass with a solvent, and removing.

[0042]

In the process which makes the hole of a ceramic sintered compact fill up with resin or glass, after being filled up with this resin or glass using the resin or glass to which elution of the part can be carried out with a solvent, some of resin with which the hole of a ceramic sintered compact was made to fill up, or glass will be removed by carrying out elution of some of resin or glass with a solvent. therefore, the thing for which the dielectric constant of a ceramic sintered compact is reduced further -- possible -- becoming -- the invention in this application -- further -- efficiency -- oh, it can close.

With in addition, the resin or glass to which elution of the part can be carried out with a solvent It is related not only with what resin itself and glass itself surely dissolve but with resin. When some base materials of raw materials for glass dissolve with a solvent about the thing which was blended with resin and which an ingredient etc. dissolves in a solvent in part and is removed, and glass, it is the large concept in which glass itself contains that from which the part is removed.

[0043]

Moreover, the manufacture approach of the ceramic electronic parts of claim 13 is characterized by said ceramic raw material being a magnetic-substance ceramic raw material.

[0044]

Without causing the fall of the mechanical reinforcement of a ceramic sintered compact by applying the invention in this application in such a case, although a magnetic-substance ceramic is used as a ceramic raw material which constitutes a ceramic sintered compact when manufacturing an inductor etc., it becomes possible to reduce a dielectric constant

and to control generating of stray capacity, and it becomes possible to manufacture efficiently ceramic electronic parts with the high dependability equipped with the desired property.

[0045]

Moreover, the manufacture approach of the ceramic electronic parts of claim 14 is characterized by being what is used in order to manufacture LC compound electronic parts which combined an inductor, the inductor section, and the capacitor section, LR compound electronic parts which combined the inductor section and resistance, or the LCR compound electronic parts which combined the inductor section, the capacitor section, and resistance.

[0046]

The manufacture approach of the ceramic electronic parts of the invention in this application can be applied when manufacturing various electronic parts, such as an inductor, LC compound electronic parts, LR compound electronic parts, and LCR compound electronic parts, without causing the fall of a ceramic sintered compact on the strength, a dielectric constant can be reduced and an inductor with small stray capacity and the high dependability equipped with the desired impedance characteristic, LC compound electronic parts, LR compound electronic parts, LCR compound electronic parts, etc. can be manufactured efficiently.

[0047]

Moreover, the manufacture approach of the ceramic electronic parts of claim 15 forms an electrode layer on the ceramic green sheet which consists said Plastic solid of said combination ceramic raw material, and is characterized by producing by carrying out two or more laminatings of the ceramic green sheet which has an electrode layer.

[0048]

When manufacturing the laminating ceramic electronic parts with which the manufacture approach of the ceramic electronic parts of the invention in this application has the laminated structure which allotted the electrode layer among two or more ceramic layers, and the anti-chip box reinforcement of a ceramic sintered compact etc. tends to become a problem, applying suitably is possible, and it enables a mechanical strength to excel in an impedance characteristic and to manufacture large and reliable laminating ceramic electronic parts efficiently by applying the invention in this application.

[0049]

[Embodiment of the Invention]

The ceramic sintered compact in the ceramic electronic parts of the

invention in this application is explained with reference to drawing 6 . As shown in drawing 6 , two or more holes 62 are formed in the interior of the ceramic sintered compact 61 in the invention in this application. The hole 62 is filled up with resin or glass 63, and the front face of a ceramic sintered compact is also covered with resin or glass 63.

The pitch diameter is 5-20 micrometers, and the hole 62 is formed at a 35 - 80vol% rate in the ceramic sintered compact 61. In addition, a hole 62 includes an open hole (opening pore) and a closed hole (closed pore). It fills up with resin or glass 63 30 - 70vol% among this hole. That is, although the whole interior may be filled up with resin or glass 63 in the hole 62, a part of the interior may be filled up and a hole 64 is further formed in that case into the resin with which it filled up in the hole 62, or glass 63.

In addition, the hole which carried out opening may be formed in the exterior as shown in drawing 6 as a mode in the case of forming a hole into resin or glass, and the hole of a large number distributed in resin or glass may be formed.

Moreover, various kinds of functional ceramics, such as a magnetic-substance ceramic, a dielectric ceramic, a semi-conductor ceramic, and a piezo electric crystal ceramic, are applicable to a ceramic sintered compact.

Hereafter, the gestalt of operation of the invention in this application is shown, and the place by which it is characterized [the] is explained in more detail.

[0050]

[Operation gestalt 1]

Production of a ceramic sintered compact which has <1> hole

In addition, this operation gestalt 1 explains how to form the ceramic sintered compact which has a hole.

[0051]

(1) First, in order that permeability μ might obtain the NiZnCu ferrite ingredient of 400, nickel, zinc, and a copper oxide raw material were mixed, and temporary quenching of the 800 degrees C was carried out for 1 hour.

(2) After that, the ball mill ground and the ferrite raw material (oxide mixing powder) with a mean particle diameter of about 2 micrometers was obtained by drying.

(3) And the spherical polymer of marketing in the obtained ferrite raw material (with this operation gestalt 1) the spherical destruction-by-fire material (mean-particle-diameter =8micrometer and a trade name:theque polymer (TECHPOLYMER) --) which consists of bridge formation

polystyrene The Sekisui Plastics Co., Ltd. (SEKISUI PLASTICS CO., LTD.) make is added at a various rate, as shown in Table 1. After having added the solvent, the binder, and the dispersant, mixing and producing a combination ceramic raw material, the ceramic green sheet with a thickness of 100 micrometers was produced with the doctor blade method using this combination ceramic raw material.

In addition, without reducing the yield, when surface area is greatly excellent in the adhesive property over a binder and adopts the large spherical polymer of firmness as destruction-by-fire material (hole formation material), it becomes possible to reduce the rate of a binder and to increase the rate of destruction-by-fire material, and it becomes possible to raise a void content.

(4) Next, it was stuck by pressure and the laminating and the Plastic solid (layered product) whose thickness is 2mm were acquired for the obtained ceramic green sheet. And the test piece of the shape of a ring configuration, disc-like, and a corner guard was produced from this Plastic solid.

(5) And after heat-treating this at 400 degrees C for 3 hours and performing a debinder, the ceramic sintered compact was obtained by calcinating at 900 degrees C for 2 hours.

In addition, with this operation gestalt 1, the rate of a hole was adjusted by changing the amount of the organic material (especially destruction-by-fire material) to mix. For example, if the rate of the destruction-by-fire material in a combination ceramic raw material is made 50vol(s)%, the rate of the hole in a ceramic sintered compact will become about 50 vol(s)%.

Moreover, the volume fraction (void content) of the hole of a ceramic sintered compact computed the specific gravity of a hole (air) from the specific gravity of a ceramic sintered compact by making the specific gravity (actual measurement) of 0 g/cm³ and a ferrite into 5.02 g/cm³.

(6) And the acquired ceramic baking object was infiltrated into the water-soluble glass (this operation gestalt 1 Li-K system glass) of a dielectric constant 3.9, and while being filled up with glass in the hole, after forming glass membrane in a ceramic sintered compact front face, melting and printing of glass were performed at 800 degrees C.

[0052]

A hole is made to fill up with glass and the measurement result of the dielectric constant after performing melting and baking, permeability, anti-chip box reinforcement, and water absorption is shown in Table 1.

[0053]

[Table 1]

試料 No.	球状 ポリ マー 平均 粒径 (μm)	空孔径 (μm)	空孔率 (vol%)	空孔にガラス含浸			吸水率 (%)		抗折強度 (MPa)	
				誘電率 1MHz	複素透磁率		含浸 前	含浸 後	含浸 前	含浸 後
					1MHz	1GHz				
1	-	-	0	14.5	430	11	0.20	-	80	-
2	8	7	10	14.0	320	7.9	1.89	0.19	74	81
3	8	7	30	11.0	220	6.6	3.72	0.12	59	82
4	8	7	35	9.9	175	5.5	4.39	0.10	51	82
5	8	7	40	9.0	150	4.8	5.75	0.08	46	82
6	8	7	50	8.1	119	3.5	10.0	0.08	34	84
7	8	7	60	7.0	89	2.9	16.4	0.07	19	84
8	8	7	70	6.3	59	2.2	18.9	0.07	14	84
9	8	7	80	5.8	49	1.8	19.5	0.07	10	84

[0054]

In addition, permeability measured a ring-like test piece, a test piece disc-like in a dielectric constant, and anti-chip box reinforcement, using a corner guard-like test piece respectively.

Although the void content of a ceramic sintered compact follows on becoming high and a dielectric constant becomes low as shown in Table 1, the anti-chip box reinforcement in the condition that you do not make it filled up with glass falls, and water absorption increases. On the other hand, it becomes possible to reduce a dielectric constant, without causing the fall of anti-chip box reinforcement, and increase of water absorption, when the hole of a ceramic sintered compact is made to fill up with glass.

That is, when filled up with glass in a hole, while becoming possible

like [in the case of the above-mentioned operation gestalt 1] to raise anti-chip box reinforcement more than an EQC or it compared with the ceramic sintered compact which does not include the hole of a sample number 1, it becomes possible to suppress water absorption low.

Moreover, as shown in the sample number 3 of Table 1, when a void content becomes 30vol(s)%, it understands that it becomes impossible for a dielectric constant to become high with 11.0 and to fully reduce a dielectric constant.

Moreover, as shown in the sample number 9 of Table 1, when a void content becomes 80vol(s)%, it turns out that what a dielectric constant is made low to six or less for (a dielectric constant in case a void content is 80vol(s)%, 5.8) becomes possible. However, if a void content exceeds 80vol(s)%, since the reinforcement after baking falls and subsequent resin, glass sinking-in processing, etc. become difficult, it is not desirable.

[0055]

In addition, even if it adds glass and resin to a ferrite and mixes to it with the ingredient which carried out kneading shaping of the resin at the calcinated composite material or magnetic powder with a ratio equivalent to the case where glass is infiltrated into the hole of Table 1 (restoration) after adding glass in a ferrite raw material and mixing in order to lower a dielectric constant although not shown in Table 1, it is checked that permeability as shown in Table 1 is not obtained. For example, when mixing percentage of glass is made into 50vol(s)% if it is in the calcinated composite material after adding glass in the ferrite raw material and mixing, it is checked that permeability μ does not become about four and complex permeability μ'' stops being almost discovered also in the frequency characteristics of permeability. Since this is divided by glass and resin whose magnetic path formed from the magnetic substance is nonmagnetic material since glass and resin are distributed so that magnetic powder may be covered and hardened when glass and resin are made to distribute magnetic powder and it considers as a Plastic solid, it is considered to be because for permeability to become low.

On the other hand, the description of the permeability of the magnetic substance itself is held in the ceramic sintered compact (hole formation ingredient) which was prepared by the approach concerning the above-mentioned operation gestalt 1 and which has a hole. Since the condition of having been connected without dividing a magnetic path within a ceramic sintered compact is maintained, this is considered to be because for high permeability to be obtained and for the description of the

permeability of the magnetic substance itself to also be held.

[0056]

Production of <2> chip-inductor components

(1) To the ceramic green sheet formed using Table 1 of the above <1>, and the ingredient (namely, ingredient with which the ceramic sintered compact whose void content is 50vol(s)% is obtained) of a sample number 6, the silver paste used as the electrode which constitutes internal coiling was printed, and a laminating and after being stuck by pressure, it cut in the shape of a chip, and calcinated at 900 degrees C.

By this, hole formation material is burned down at the time of baking, it has the internal electrode of a silver system, and the ceramic baking object which included the hole at a 50vol% rate is acquired.

(2) Next, the ceramic sintered compact was immersed in the water-soluble glass (this operation gestalt 1 Li-K system glass) of a dielectric constant 3.9, and the interior of hole was made to fill up with water-soluble glass.

(3) And after applying the conductive paste for external electrodes so that it may flow with an internal electrode in a both-ends side parallel to the direction of an axial center of a coil of a ceramic sintered compact, the glass and conductive paste with which the hole was made to fill up were calcinated to coincidence by heat-treating at 800 degrees C. This obtained the chip inductor component (example 1) with a width of face [die length of 1.6mm and width of face] which have the structure where the coil 2 was arranged in the interior of the ceramic sintered compact 1, and the external electrodes 3a and 3b were arranged in the both ends of a ceramic sintered compact, and a height of 0.8mm, as shown in drawing 1 . In addition, in the chip inductor components of this example 1, the number of turns of a coil was considered as 30 turns.

[0057]

Moreover, chip inductor components (example 1 of a comparison) were produced by the same approach as the above-mentioned example 1 using the ceramic green sheet which consists of the usual ferrite material

(ingredient with which the ceramic sintered compact Table 1 of the above <1> and whose void content of a sample number 1 are 0vol% is obtained) for the comparison. In addition, in order to make the comparison of a property easy, with the chip inductor components of the example 1 of a comparison, the number of turns of a coil was considered as 20 turns so that the inductance in a low frequency band might serve as a near value.

[0058]

The chip inductor components of this example 1 and the example 1 of a comparison were connected to network analyzer HP8753D, the reflection

property was measured, and the impedance was computed from that result. The impedance characteristic of the chip inductor components of an example 1 and the example 1 of a comparison is shown in drawing 2 .

[0059]

In the chip inductor components of this example 1, since the magnetic substance to which the dielectric constant was reduced is used without spoiling the property of permeability by forming a hole, in a low frequency field, it turns out that a desired impedance is securable to a RF field with low dielectric constant-ization, with the same impedance characteristic as usual maintained.

That is, with the chip inductor components of the example 1 of a comparison, although the frequency from which the impedance of 600 ohms is obtained is to about 1.3GHz, in the chip inductor components of an example 1, it turns out that the band where the impedance of 600 ohms is obtained is expanded to about 4GHz.

[0060]

Moreover, in the chip inductor components of this example 1, since the interior of hole of a ceramic sintered compact is made to fill up with glass, compared with the chip inductor components of the example 1 of a comparison using the ferrite material which does not include the conventional hole, there is no inferiority in anti-chip box reinforcement, and it is lower than the chip inductor components of the example 1 of a comparison about water absorption, and excelling the example 1 of a comparison also in the field of dependability is checked.

[0061]

[Operation gestalt 2]

Production of a ceramic sintered compact which has <1> hole

(1) By changing the amount of the organic material to mix like the above-mentioned operation gestalt 1, the rate of a hole was adjusted and the same ceramic sintered compact as what was obtained by (5) of <1> was produced. [of the operation gestalt 1]

(2) And after infiltrating the epoxy resin of a dielectric constant 3.4 into the hole of a ceramic sintered compact, it heated at 150 degrees C and it was made to harden an epoxy resin.

Thus, a dielectric constant, permeability, anti-chip box reinforcement, and water absorption were measured about the ceramic sintered compact which made the hole fill up with resin. The result is shown in Table 2.

[0062]

[Table 2]

試料 No.	球状 ポリ マー 平均 粒径 (μm)	平均 空孔径 (μm)	空孔率 (vol%)	空孔に樹脂含浸			吸水率 (%)		抗折強度 (MPa)	
				誘電率 1MHz	複素透磁率		含浸 前	含浸 後	含浸 前	含浸 後
					1MHz	1GHz				
11	-	-	0	14.5	430	11	0.20	-	80	-
12	8	7	10	13.9	330	8.0	1.89	0.17	74	80
13	8	7	30	10.9	212	6.0	3.89	0.10	53	80
14	8	7	35	9.8	182	5.7	4.39	0.09	51	80
15	8	7	40	8.9	153	4.9	5.75	0.09	46	82
16	8	7	50	7.9	123	3.6	10.0	0.06	34	81
17	8	7	60	6.8	92	2.9	16.4	0.03	19	86
18	8	7	70	6.2	61	2.3	18.9	0.03	14	89
19	8	7	80	5.3	41	1.8	21.5	0.03	10	90

[0063]

Table 2 shows that it becomes possible to raise anti-chip box reinforcement more than an EQC or it compared with what does not include the hole of a sample number 11 (it is the same as the sample number 1 of Table 1), when an epoxy resin is made to be infiltrated into the hole of a ceramic sintered compact (restoration).

Moreover, also when a void content is made into 80% (sample number 19), what sank in the epoxy resin makes a void content 30%, and is understood that anti-chip box reinforcement is larger than what was made not to sink in about the epoxy resin.

[0064]

Moreover, it turns out that water absorption is stabilized about water absorption in that into which the epoxy resin was infiltrated lower than

what does not include the hole of a sample number 11.

Furthermore, also when the hole ratio was more than 35vol% and an epoxy resin is infiltrated, it turns out that ten or less dielectric constant is securable.

In addition, although the way of resin may be able to choose what has a low dielectric constant compared with glass, and it is some compared with the case where glass is infiltrated like said operation gestalt 1 when the epoxy resin used this time is used, it turns out that it becomes possible to reduce a dielectric constant further.

[0065]

Production of <2> chip-inductor components

(1) To the ceramic green sheet formed using Table 2 of the above <1>, and the ingredient (namely, ingredient with which the ceramic sintered compact whose void content is 50vol(s)% is obtained) of a sample number 16, the silver paste used as the electrode which constitutes internal coiling was printed, and a laminating and after being stuck by pressure, it cut into the chip configuration and calcinated at 900 degrees C. The ceramic baking object which the organic material was burned down and included the hole at a 50vol(s)% rate by this at the time of baking is acquired.

(2) And after applying the conductive paste for external electrode formation so that it may flow with an internal electrode in a both-ends side parallel to the direction of an axial center of the coil of a ceramic sintered compact, by heat-treating at 850 degrees C, conductive paste was calcinated and the external electrode was formed.

(3) Next, after infiltrating this chip into the liquefied resin of the epoxy system of a dielectric constant 3.4, it was made to harden at 150 degrees C, and the resin film was formed in the ceramic sintered compact front face while being filled up with the epoxy resin in the hole of a ceramic sintered compact.

(4) And after carrying out barrel finishing of the chip into which resin was infiltrated and exposing the surface of metal of an external electrode more certainly, nickel plating and Sn plating were performed and the deposit was formed in the front face of an external electrode. This obtained the chip inductor component (example 2) with die length of 1.6mm, a width of face, and a height of 0.8mm. In addition, in the chip inductor components of this example 2, the number of turns of a coil was considered as 30 turns.

[0066]

The chip inductor components (20 turns) same as chip inductor components for a comparison as the example 1 of a comparison produced with the

above-mentioned operation gestalt 1 were prepared.

And the chip inductor components of this example 2 were connected to network analyzer HP8753D, the reflection property was measured, and the impedance was computed from that result. The impedance characteristic of the chip inductor components of an example 2 and the example 1 of a comparison is shown in drawing 3 .

[0067]

In the chip inductor components of this example 2, since the magnetic substance to which the dielectric constant was reduced is used without spoiling the property of permeability greatly by forming a hole, in a low frequency field, it turns out that a desired impedance is securable to a RF field with low dielectric constant-ization, with the same impedance characteristic as usual maintained.

That is, with the chip inductor components of the example 1 of a comparison, although the frequency from which the impedance of 600 ohms is obtained is to about 1.3GHz, in the chip inductor components of an example 2, it turns out that the band where the impedance of 600 ohms is obtained is expanded to about 5GHz.

[0068]

Moreover, in the chip inductor components of this example 2, since it is made to infiltrate an epoxy resin into the interior of hole of a ceramic sintered compact (restoration), compared with the chip inductor components of the example 1 of a comparison using the ferrite material which does not include the conventional hole, there is no inferiority in anti-chip box reinforcement, and it is lower than the chip inductor components of the example 1 of a comparison about water absorption, and excel the example 1 of a comparison also in the field of dependability is check.

[0069]

[Operation gestalt 3]

(1) By the same approach as the above-mentioned operation gestalten 1 and 2, the void content produced the porosity ferrite (ceramic sintered compact) which is 60vol(s)%.

(2) And after being immersed into the solvent which diluted this porosity ferrite with the organic solvent so that viscosity might be set to 300mPa(s).s and 500mPa(s).s in the epoxy resin of a dielectric constant 3.4 and infiltrating an epoxy resin (restoration), it heated at 150 degrees C for 30 minutes, and the epoxy resin was stiffened.

[0070]

And a void content, a dielectric constant, and anti-chip box reinforcement were measured about sinking [which carried out in this

way and was acquired / of an epoxy resin] in, and the porosity ferrite after hardening.

In addition, by 8.4, viscosity infiltrated the non-solvent type epoxy resin of 5000mPa(s).s, and the dielectric constant measured a void content, a dielectric constant, and anti-chip box reinforcement about the sample stiffened similarly. The result is shown in Table 3.

[0071]

[Table 3]

含浸材	空孔率 (vol%)	誘電率	抗折強度 (M p a)
含浸前	60	6.6	20
粘度300mPa.s エポキシ含浸後	58	6.8	120
粘度500mPa.s エポキシ含浸後	57	6.9	131
粘度5000mPa.s エポキシ含浸後	27	8.4	130

[0072]

When viscosity uses the epoxy resin of 500 or less mPa-s, it turns out that a hole is formed also in the epoxy resin infiltrated (restoration), it is high intensity and the porosity ferrite of further a low dielectric constant is obtained.

This is because the diluent in the epoxy resin with which you made it filled up in the hole of a porosity ferrite volatilized and the hole was formed also in the interior of an epoxy resin.

In addition, it is possible to for example once apply the approach of volatilizing a solvent and hardening etc. as an approach of forming a hole in the resin with which it filled up in the hole of a porosity ferrite, or glass, after carrying out elution of some base materials of the resin which performed ultrasonic cleaning etc. within the solvent and was infiltrated after infiltrating high resin and the raw materials for glass of viscosity other than the above-mentioned approach, or raw

materials for glass.

[0073]

[Operation gestalt 4]

Drawing 4 and 5 are drawings showing the ceramic electronic parts (T mold LC filter) concerning the operation gestalt of the invention in this application, and the decomposition perspective view in which drawing 4 shows the configuration, and drawing 5 are typical sectional views.

The ceramic electronic parts 11 of this operation gestalt 4 are T mold LC filters (laminating mold LC filter) which have the structure where the capacitor section 14 was arranged among the inductor sections (coil section) 12 and 13.

[0074]

In this T mold LC filter the inductor section 12 a coil -- the magnetic layer 22 which formed Conductors 35a, 35b, and 35c and the beer halls 36a, 36b, and 36c for junction, the magnetic layer 22 which prepared beer hall 37a for cash drawers, and the object for cash drawers -- a conductor -- it constitutes from a magnetic layer 22 which prepared 38a -- having -- **** -- a coil -- Conductors 35a-35c The coil 26 is formed by connecting through the beer halls 36b and 36c for junction.

[0075]

Moreover, the inductor section 13 It consists of magnetic layers 22 which prepared conductor 38b and beer hall 37c for cash drawers. a coil -- the magnetic layer 22 which formed Conductors 35d, 35e, and 35f and the beer halls 36d, 36e, and 36f for junction, the magnetic layer 22 which prepared beer hall 37b for cash drawers, and the object for cash drawers -- a coil -- Conductors 35d-35f form the coil 27 by connecting through the beer halls 36e and 36f for junction.

[0076]

Moreover, the capacitor section 14 is equipped with the grand electrode 30, the through electrode 31, the dielectric layer 23 that formed the beer halls 41b and 42a for through electrode connection, the dielectric layer 23 which formed the beer halls 41a, 41c, and 42b for through electrode connection, and the capacitor 33 is formed from the grand electrode 30 arranged so that it might counter mutually, and the through electrode 31.

[0077]

And a magnetic layer 22 and a dielectric layer 23 are accumulated, as shown in drawing 5, the external electrode 51 for an input and the external electrode 52 for an output are arranged by the both ends of the ceramic sintered compact formed by sintering to one, and the external

electrode 53 for touch-down is arranged in the center section of the ceramic sintered compact.

[0078]

In T mold LC filter of this operation gestalt 4, the ferrite ingredient which has a hole explaining that manufacture approach is used with the operation gestalten 1-3 as a component of the magnetic layer which constitutes the inductor sections 12 and 13, and the dielectric ceramic ingredient is used for the capacitor section 14.

[0079]

In this T mold LC filter, since the ferrite ingredient with the low dielectric constant which has a hole is used as a component of the magnetic layer which constitutes the inductor sections 12 and 13, the filter which was excellent in the noise damping property in a RF can be obtained.

Moreover, the ferrite ingredient including the hole where this T mold filter is used as a magnetic-substance ingredient was reinforced with resin, glass, etc. with which it filled up in the hole, and is equipped with sufficient dependability from having the outstanding anti-chip box reinforcement.

[0080]

In addition, although this operation gestalt 4 explained taking the case of T mold LC filter, it is also possible to manufacture LR compound electronic parts which combined the inductor section using a ferrite ingredient and the resistance section of the invention in this application, the LCR compound electronic parts which combined the inductor section, the capacitor section, and the resistance section.

[0081]

In addition, although each above-mentioned operation gestalt explained the case where the destruction-by-fire material which consists of bridge formation polystyrene was used as destruction-by-fire material, it is also possible to use the destruction-by-fire material which consists of an ingredient of other destruction-by-fire nature.

Moreover, although spherical destruction-by-fire material is used as destruction-by-fire material with the above-mentioned operation gestalt, it is possible not only a spherical thing but to use particulate matter-like destruction-by-fire material.

[0082]

Moreover, although the ingredient which constitutes a ceramic sintered compact explained with the above-mentioned operation gestalt taking the case of the case where it is a nickel-Zn-Cu system ferrite ingredient, when using other ferrite ingredients, or also when using ingredients

other than a ferrite, it is possible to apply the invention in this application.

[0083]

The invention in this application can add various application and deformation within the limits of invention also in other points about the baking conditions for making the approach and destruction-by-fire material which are made to fill up with the resin with which it is not limited to the above-mentioned operation gestalt, and the hole of a ceramic sintered compact is made to fill up or the class of glass, resin, or glass burned down etc. further.

[0084]

[Effect of the Invention]

As mentioned above, since the ceramic electronic parts of the invention in this application (claim 1) are making the hole fill up with resin or glass while including a hole in a ceramic sintered compact at a 35 - 80vol% rate, it enables it to become possible to reduce a dielectric constant and to control generating of stray capacity, without causing the fall of a ceramic sintered compact on the strength.

that is, the 35 - 80vol% thing for which the dielectric constant of a ceramic sintered compact is reduced sharply becomes possible at a ceramic sintered compact, without securing the continuity (it being the continuity of a magnetic path especially in the case of a magnetic-substance ceramic) of the ceramic grain of a ceramic sintered compact, and reducing greatly the electrical property (it being magnetic property especially in the case of a magnetic-substance ceramic) of a ceramic sintered compact, since it comes out comparatively and he is trying to include a hole. On the other hand, since the hole of a ceramic sintered compact is filled up with resin or glass, it becomes possible to secure the reinforcement of a ceramic sintered compact. Therefore, it enables a mechanical strength to excel in the impedance characteristic in a RF field, and to obtain large and reliable ceramic electronic parts.

[0085]

A ceramic sintered compact the ceramic electronic parts of claim 2 Moreover, a ceramic raw material, It is formed [calcinate / spherical or / a binder and / the Plastic solid of the combination ceramic raw material which blended the destruction-by-fire material which has an adhesive property over a binder by the shape of a particulate matter]. From containing the with an extent [35 - 80vol% of] which does not divide a magnetic path hole, when especially a ceramic sintered compact is a magnetic-substance ceramic It has desired magnetic property, and there can be little generating of stray capacity and ceramic electronic

parts with the high dependability equipped with the desired property can be offered now.

[0086]

moreover, the thing for which the dielectric constant of a ceramic sintered compact is further reduced by including a hole further like the ceramic electronic parts of claim 3 into the resin with which said hole was filled up, or glass -- possible -- becoming -- the invention in this application -- further -- efficiency -- oh, it can close.

[0087]

Moreover, without causing the fall of the mechanical reinforcement of a ceramic sintered compact by applying the invention in this application like claim 4, when a magnetic-substance ceramic is used as a ceramic raw material which constitutes a ceramic sintered compact, it becomes possible to reduce a dielectric constant and to control generating of stray capacity, and it becomes possible to offer ceramic electronic parts with the high dependability equipped with the desired property (inductor etc.).

[0088]

Moreover, the invention in this application can be applied to various ceramic electronic parts, such as an inductor, LC compound electronic parts, LR compound electronic parts, or LCR compound electronic parts, like claim 5, and can offer the electronic parts with which the reinforcement of a ceramic sintered compact was large with electronic parts and generating of stray capacity was equipped with few desired properties.

[0089]

Moreover, it is possible to apply suitable for the laminating ceramic electronic parts with which the invention in this application has the laminated structure which allotted the electrode layer among two or more ceramic layers like claim 6, and the anti-chip box reinforcement of a ceramic sintered compact etc. tends to become a problem, and it enables a mechanical strength to come to carry out the laminating of the ceramic layer with a low dielectric constant, and to obtain large and reliable laminating ceramic electronic parts by applying the invention in this application.

[0090]

Moreover, while it becomes possible for you to make it fully filled up with resin or glass in a hole by setting the pitch diameter of a hole to 5-20 micrometers like the ceramic electronic parts of claim 7, it becomes possible to prevent the fall of the reinforcement of the magnetic substance with which the hole was formed, and it becomes

possible to obtain reliable laminating ceramic electronic parts.

[0091]

Moreover, it becomes possible like the ceramic electronic parts of claim 8 to raise the reinforcement of a ceramic sintered compact further by covering the front face of a ceramic sintered compact with resin or glass. In addition, it can prevent causing complication of a production process by using the resin with which it was filled up in the hole, the same resin as glass, or glass as resin or glass.

[0092] Moreover, the manufacture approach of the ceramic electronic parts of the invention in this application (claim 9) A ceramic raw material, a binder, and the combination ceramic raw material spherical or for the ceramic sintered compacts which blended the destruction-by-fire material which has an adhesive property over a binder by the shape of a particulate matter are used. After forming the Plastic solid with which the electrode (electrode material) was arranged in the interior and forming the ceramic sintered compact which includes a 35 - 80vol% hole by calcinating this Plastic solid, Since he is trying to make said hole of a ceramic sintered compact fill up with resin or glass A hole is formed in a ceramic sintered compact, securing the continuity of the ceramic grain in a ceramic sintered compact. While becoming possible to reduce the dielectric constant of a ceramic sintered compact sharply, without reducing the various electrical properties of a ceramic sintered compact greatly The resin or glass with which you made it filled up all over a hole enables it to raise the reinforcement of a ceramic sintered compact, and ceramic electronic parts with the high dependability equipped with the desired property can be manufactured efficiently.

[0093]

Moreover, when what uses as a principal component at least one sort chosen from the group which consists of bridge-formation polystyrene, a bridge-formation polymethyl methacrylate, bridge-formation polymethacrylic acid butyl, bridge-formation polymethacrylic acid ester, and bridge-formation polyacrylic ester as destruction-by-fire material blended with a ceramic raw material like the manufacture approach of the ceramic electronic parts of claim 10 is used, it becomes possible to form a hole in a ceramic sintered compact certainly at a baking process, and it becomes possible to form efficiently the ceramic sintered compact which has a desired void content.

[0094]

Moreover, it sets like the manufacture approach of the ceramic electronic parts of claim 11 at the process which makes the hole of a ceramic sintered compact fill up with resin or glass. As resin or glass,

the resin or glass which blended the solvent or the diluent is used. When it is made to volatilize a solvent or a diluent after filling up a hole with resin or glass, into resin or glass, it becomes possible to form a hole further and the dielectric constant of a ceramic sintered compact can be reduced further.

[0095]

Moreover, it sets like the manufacture approach of the ceramic electronic parts of claim 12 at the process which makes the hole of a ceramic sintered compact fill up with resin or glass. As resin or glass, the resin or glass to which elution of the part can be carried out with a solvent is used. When the elution of some of resin or glass is made to be carried out with a solvent after being filled up with this resin or glass, some of resin with which the hole of a ceramic sintered compact was made to fill up, or glass is removed. reducing the dielectric constant of a ceramic sintered compact further -- possible -- becoming -- the invention in this application -- further -- efficiency -- oh, it can close.

[0096]

Moreover, without causing the fall of a ceramic sintered compact on the strength by applying the invention in this application like claim 13, when a magnetic-substance ceramic is used like an inductor as a ceramic which constitutes a ceramic sintered compact, it becomes possible to reduce a dielectric constant and to control generating of stray capacity, and ceramic electronic parts with the high dependability equipped with the desired impedance characteristic can be obtained.

[0097]

Like the manufacture approach of the ceramic electronic parts of claim 14, moreover, the manufacture approach of the ceramic electronic parts of the invention in this application It is possible to apply, when manufacturing various electronic parts, such as an inductor, LC compound electronic parts, LR compound electronic parts, and LCR compound electronic parts. Without causing the fall of a ceramic sintered compact on the strength, a dielectric constant is reduced, stray capacity can be small and an inductor with the high dependability equipped with the desired impedance characteristic, LC compound electronic parts, LR compound electronic parts, LCR compound electronic parts, etc. can be manufactured efficiently.

[0098]

Like the manufacture approach of the ceramic electronic parts of claim 15, moreover, the manufacture approach of the ceramic electronic parts of the invention in this application By having the laminated structure

which allotted the electrode layer among two or more ceramic layers, applying suitably being possible when manufacturing the laminating ceramic electronic parts with which the anti-chip box reinforcement of a ceramic sintered compact etc. tends to become a problem, and applying the invention in this application It enables a mechanical strength to excel in an impedance characteristic and to manufacture large and reliable laminating ceramic electronic parts efficiently.

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing the chip inductor components concerning 1 operation gestalt of the invention in this application.

[Drawing 2] It is drawing showing the impedance characteristic of the chip inductor components (example 1) concerning 1 operation gestalt (operation gestalt 1) of the invention in this application.

[Drawing 3] It is drawing showing the impedance characteristic of the chip inductor components (example 2) concerning other operation gestalten (operation gestalt 2) of the invention in this application.

[Drawing 4] It is the decomposition perspective view showing the configuration of the ceramic electronic parts (T mold LC filter) concerning other operation gestalten (operation gestalt 4) of the invention in this application.

[Drawing 5] It is the sectional view showing typically the configuration of the ceramic electronic parts (T mold LC filter) concerning other operation gestalten (operation gestalt 4) of the invention in this application.

[Drawing 6] It is the sectional view showing typically some ceramic sintered compacts in the ceramic electronic parts of the invention in this application.

[Description of Notations]

1 Ceramic Sintered Compact

2 Coil

3a, 3b External electrode

11 Ceramic Electronic Parts (T Mold LC Filter)

12 13 Inductor section (coil section)

14 Capacitor Section

22 Magnetic Layer

23 Dielectric Layer

26 27 Coil

30 Grand Electrode

31 Through Electrode

33 Capacitor

35a, 35b, 35c, 35d, 35e, and 35f a coil -- conductor
36a, 36b, 36c, 36d, 36e, 36f Beer hall for junction
37a, 37b, 37c Beer hall for cash drawers
38a and 38b the object for cash drawers -- conductor
41b, 42a Beer hall for through electrode connection
41a, 41c, 42b Beer hall for through electrode connection
51 External Electrode for Input
52 External Electrode for Output
53 External Electrode for Touch-down
61 Ceramic Sintered Compact
62 Hole
63 Resin or Glass
64 Hole

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the sectional view showing the chip inductor components concerning 1 operation gestalt of the invention in this application.

[Drawing 2] It is drawing showing the impedance characteristic of the chip inductor components (example 1) concerning 1 operation gestalt (operation gestalt 1) of the invention in this application.

[Drawing 3] It is drawing showing the impedance characteristic of the chip inductor components (example 2) concerning other operation gestalten (operation gestalt 2) of the invention in this application.

[Drawing 4] It is the decomposition perspective view showing the configuration of the ceramic electronic parts (T mold LC filter) concerning other operation gestalten (operation gestalt 4) of the

invention in this application.

[Drawing 5] It is the sectional view showing typically the configuration of the ceramic electronic parts (T mold LC filter) concerning other operation gestalten (operation gestalt 4) of the invention in this application.

[Drawing 6] It is the sectional view showing typically some ceramic sintered compacts in the ceramic electronic parts of the invention in this application.

[Description of Notations]

1 Ceramic Sintered Compact

2 Coil

3a, 3b External electrode

11 Ceramic Electronic Parts (T Mold LC Filter)

12 13 Inductor section (coil section)

14 Capacitor Section

22 Magnetic Layer

23 Dielectric Layer

26 27 Coil

30 Grand Electrode

31 Through Electrode

33 Capacitor

35a, 35b, 35c, 35d, 35e, and 35f a coil -- conductor

36a, 36b, 36c, 36d, 36e, 36f Beer hall for junction

37a, 37b, 37c Beer hall for cash drawers

38a and 38b the object for cash drawers -- conductor

41b, 42a Beer hall for through electrode connection

41a, 41c, 42b Beer hall for through electrode connection

51 External Electrode for Input

52 External Electrode for Output

53 External Electrode for Touch-down

61 Ceramic Sintered Compact

62 Hole

63 Resin or Glass

64 Hole

[Translation done.]

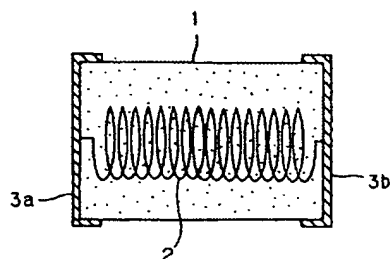
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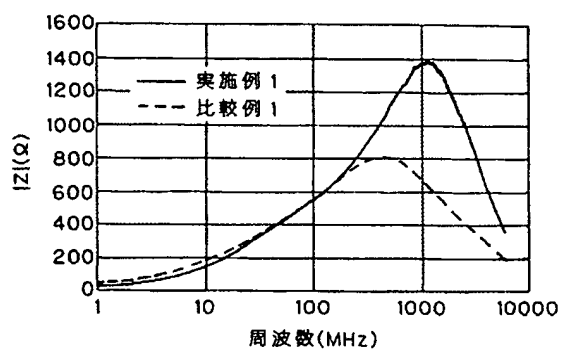
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DRAWINGS

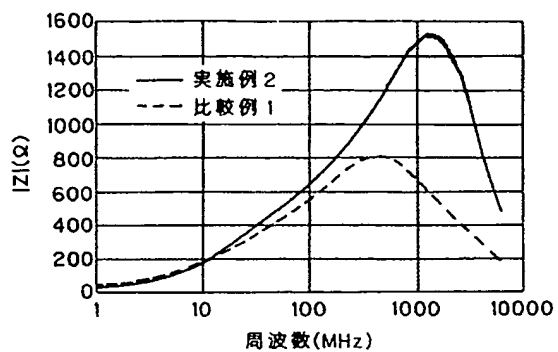
[Drawing 1]



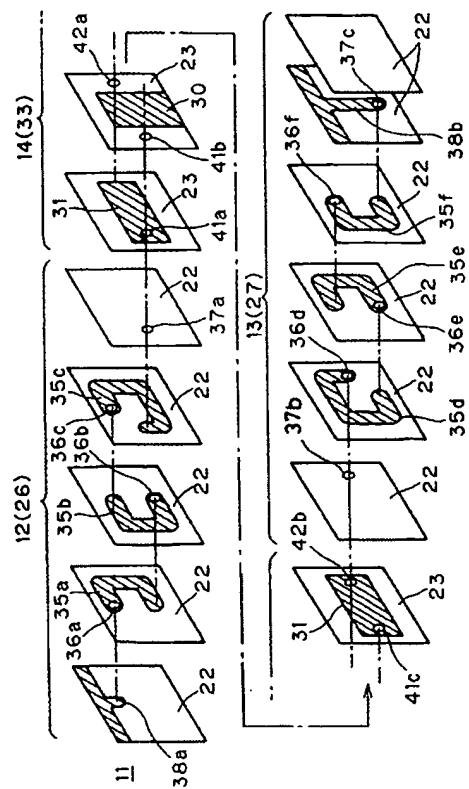
[Drawing 2]



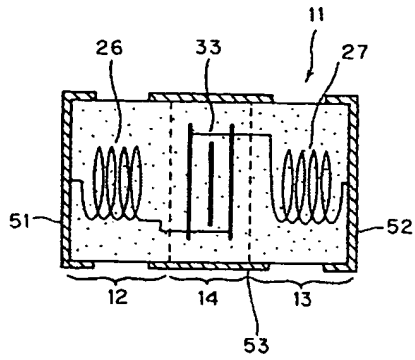
[Drawing 3]



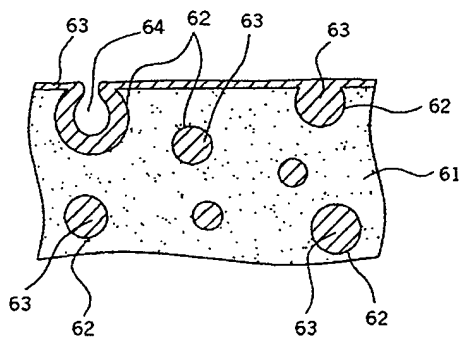
[Drawing 4]



[Drawing 5]



[Drawing 6]



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Bibliography

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(43) [Date of Publication] December 24, Heisei 11 (1999)
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38/00 301
H01G 4/12 349
H05K 3/46
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C04B 35/64 G
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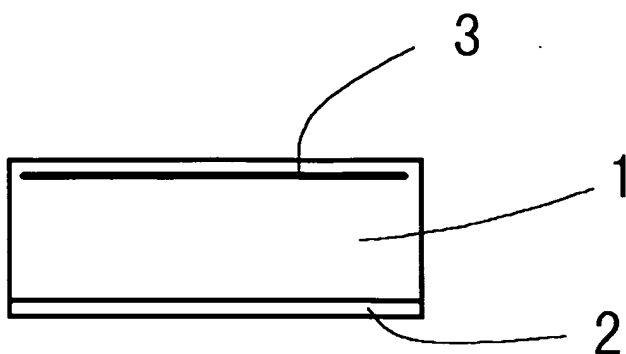
Epitome

(57) [Abstract]

[Technical problem] Even if the electrode pattern formed in the layered product is in a condition imbalanced in the direction of a laminating, the ceramic layered product which can control deformation is offered.

[Means for Solution] In order to control deformation of a layered product, the layered product in which the 2nd ceramic layer of the burning shrinkage of the green sheet which constitutes the main ceramic layer of a ceramic layered product, and different burning shrinkage was formed is calcinated.

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CLAIMS

[Claim(s)]

[Claim 1] The ceramic layered product characterized by forming the 2nd ceramic layer which has a different void content from the main ceramic layer of said ceramic layered product in the ceramic layered product which carried out the laminating of the ceramic green sheet with which the electrode pattern was formed, came to calcinate it, and constituted the predetermined circuit inside in order to control deformation of said layered product.

[Claim 2] The void content of said 2nd ceramic layer is a ceramic layered product according to claim 1 which is 5% - 20% and is characterized by being larger than the void content of said main ceramic layer.

[Claim 3] The ceramic layered product characterized by forming the 2nd ceramic layer which has a different consistency from the main ceramic layer of said ceramic layered product in the ceramic layered product which carried out the laminating of the ceramic green sheet with which the electrode pattern was formed, came to calcinate it, and constituted

the predetermined circuit inside in order to control deformation of said layered product.

[Claim 4] The ceramic layered product according to claim 3 to which the consistency of said 2nd ceramic layer is characterized by being 70% - 95% of the consistency of said main ceramic layer.

[Claim 5] One which is characterized by consisting of two or more ceramic ingredients with which said main ceramic layers differ of ceramic layered products according to claim 1 to 4.

[Claim 6] One which is characterized by said main ceramic layer and said 2nd ceramic layer being these components of ceramic layered products according to claim 1 to 5.

[Claim 7] The manufacture approach of the ceramic layered product characterized by calcinating the layered product in which the 2nd ceramic layer of the burning shrinkage of the green sheet which constitutes the main ceramic layer of said ceramic layered product, and different burning shrinkage was formed in the manufacture approach of the ceramic layered product which carried out the laminating of the ceramic green sheet with which the electrode pattern was formed, came to calcinate it, and constituted the predetermined circuit inside in order to control deformation of said layered product.

[Claim 8] The burning shrinkage of said 2nd ceramic layer is the manufacture approach of the ceramic layered product according to claim 7 characterized by being 50% - 90% of the burning shrinkage of a main ceramic layer.

[Claim 9] The manufacture approach of the ceramic layered product according to claim 7 or 8 characterized by consisting of two or more ceramic ingredients with which said main ceramic layers differ.

[Claim 10] The manufacture approach of one which is characterized by said main ceramic layer and the 2nd ceramic layer being these components of ceramic layered products according to claim 7 to 9.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to controlling the deformation about the ceramic layered product by which the predetermined circuit pattern was formed in the interior.

[0002]

[Description of the Prior Art] An electrode pattern is printed to a ceramic green sheet, and the ceramic layered product which carries out the laminating of it and comes to calcinate it is used for a chip, the circuit board, etc.

[0003] From the slurry which mixed the solvent etc. with temporary quenching and the ground ceramic powder, this ceramic layered product produced the green sheet, formed the through hole in that green sheet suitably by punching, screen-stenciled electrode paste, such as silver and copper, formed the predetermined electrode pattern on the green sheet, carried out the laminating of this, calcinated it, and has obtained the ceramic layered product. Moreover, as for a baking front stirrup, a cutting process may enter behind.

[0004]

[Problem(s) to be Solved by the Invention] Although this ceramic layered product was really calcinated at about 900-1000 degrees C, at this time, the contraction properties of a ceramic layer and an electrode might differ and the ceramic layered product might deform it. When, as for this, an electrode section generally starts contraction early and a ceramic layer contracts, an electrode section is not contracted but it is thought that it is because uniform contraction of a ceramic layer is checked.

[0005] When the structure of the electrode pattern inside a ceramic layered product is imbalanced in the direction of a laminating, deformation especially becomes large. For example, as shown in drawing 5 (b), when the electrode pattern 51 was formed in the direction of a laminating at the symmetry, it could calcinate almost in the condition without deformation, but the electrode pattern 51 was unsymmetrical in the direction of a laminating, as shown in drawing 5 (a), when formed in imbalance, the difference was produced in contraction of the side which the electrode is concentrating, and contraction of the side which is not concentrated, and deformation as shown in drawing had produced.

[0006] This invention aims at offering the ceramic layered product which

can control deformation, even if the electrode pattern formed in the layered product in view of the above-mentioned thing is in a condition imbalanced in the direction of a laminating.

[0007]

[Means for Solving the Problem] In order that this invention may control deformation of said layered product in the ceramic layered product which carried out the laminating of the ceramic green sheet with which the electrode pattern was formed, came to calcinate it, and constituted the predetermined circuit inside, the main ceramic layer of said ceramic layered product is a ceramic layered product in which the 2nd ceramic layer which has a different void content is formed.

[0008] Moreover, the void content of said 2nd ceramic layer is 5% - 20%, and this invention's is larger than the void content of said main ceramic layer.

[0009] Moreover, in order that this invention may control deformation of said layered product in the ceramic layered product which carried out the laminating of the ceramic green sheet with which the electrode pattern was formed, came to calcinate it, and constituted the predetermined circuit inside, the main ceramic layer of said ceramic layered product is a ceramic layered product in which the 2nd ceramic layer which has a different consistency is formed.

[0010] Moreover, as for this invention, the consistency of said 2nd ceramic layer has turned into 70% - 95% of the consistency of said main ceramic layer.

[0011] Moreover, in the manufacture approach of the ceramic layered product which carried out the laminating of the ceramic green sheet with which the electrode pattern was formed, and constituted the predetermined circuit inside, this invention is the manufacture approach of the ceramic layered product which calcinates the layered product in which the 2nd ceramic layer of the burning shrinkage of the green sheet which constitutes the main ceramic layer of said ceramic layered product, and different burning shrinkage was formed, in order to control deformation of said layered product.

[0012] Moreover, the burning shrinkage of this invention of said 2nd ceramic layer is 50% - 90% of the burning shrinkage of a main ceramic layer.

[0013] Moreover, the main ceramic layer may consist of two or more different ceramic ingredients, and, as for this invention, it is [the 2nd ceramic layer] desirable that it is the same component as a main ceramic layer.

[0014]

[Embodiment of the Invention] This invention makes the 2nd ceramic layer intervene so that the well-balanced stress may work like the case where the electrode pattern is formed in the direction of a laminating at the symmetry, when for example, an electrode pattern is imbalanced in the direction of a laminating. It is suitable for this 2nd ceramic layer that burning shrinkage is smaller than a main ceramic layer. Preferably, it is 50% - 90% of the burning shrinkage of a main ceramic layer.

[0015] Moreover, let this 2nd ceramic layer be the thing of a different void content from a main ceramic layer. And the void content of the 2nd ceramic layer is 5% - 20%, and it is desirable that it is larger than the void content of said main ceramic layer.

[0016] Moreover, let this 2nd ceramic layer be the thing of a different consistency from a main ceramic layer. And it is desirable that the consistency of said 2nd ceramic layer is 70% - 95% of a consistency of said main ceramic layer.

[0017] As for this 2nd ceramic layer, it is desirable that it is a main ceramic layer and this main component. For this reason, although it is this component, it is necessary to change burning shrinkage. For that, there are the following means.

(a) Use the ceramic raw material powder with which the temporary-quenching powder with which usual is not crystallizing the fully crystallized powder was mixed.

(b) Use the ceramic raw material powder with which the temporary-quenching powder with which usual is not crystallizing the powder into which temporary-quenching temperature was changed into and the degree of crystallization was changed was mixed.

[0018]

[Example] As a ceramic ingredient, the oxide of aluminum, Si, calcium, Sr, K, Na, and Pb was mixed, and the ceramic powder (suppose that it is usually called temporary-quenching powder) which carried out temporary quenching and which was ground at 750 degrees C was used. This ceramic powder can be calcinated at 900 degrees C, and will be in the alumina after baking, and the mixed-crystal condition of a feldspar group mineral crystal. Moreover, the condition after temporary quenching is in the condition that what components other than an alumina and an alumina vitrified is intermingled. This was made into the ingredient of a main ceramic layer.

[0019] Next, the ingredient of the 2nd ceramic layer is explained. First, temporary quenching of a main ceramic ingredient and the ingredient of this presentation is carried out at 900 degrees C, and the ground temporary-quenching powder (suppose that it is called elevated-

temperature temporary-quenching powder) is obtained. It is the ingredient which carries out temporary quenching of this elevated-temperature temporary-quenching powder, it has at the same temperature as burning temperature, and was fully crystallized. Temporary-quenching powder was usually mixed with this elevated-temperature temporary-quenching powder, and it considered as the 2nd ceramic ingredient. [0020] The 2nd ceramic ingredient of the compounding ratio shown in Table 1 was calcinated independently, and the material property was evaluated. The result is shown in Table 1. The charge of a principal member of Table 1 is a property ceramic ingredient independent [main]. The dielectric loss of Table 1 was measured by 10GHz - 15GHz by the cylinder resonator method. Moreover, the rate of a density ratio is a ratio of each consistency when making the consistency of the charge of a principal member into 100%. A contraction ratio is a ratio of each burning shrinkage when making burning shrinkage of the charge of a principal member into 100%. As shown in Table 1, a consistency, burning shrinkage, and a void content can be set as a suitable value by usually mixing temporary-quenching powder and elevated-temperature temporary-quenching powder.

[0021]

[Table 1]

	通常仮焼粉 (w t %)	高温仮焼粉 (w t %)	誘電率	誘電損失
主材料	1 0 0	0	8	6×10^{-4}
試料 1	9 5	5	7	10×10^{-4}
試料 2	8 0	2 0	5. 8	13×10^{-4}
試料 3	5 0	5 0	4. 5	23×10^{-4}
試料 4	0	1 0 0	3. 8	28×10^{-4}

	密度 (g/cm ³)	密度比率 (%)	空孔率 (%)	焼成収縮率 (%)	収縮率比率 (%)
主材料	3. 2	1 0 0	1	2 0. 0	1 0 0
試料 1	2. 8	8 7. 5	1 3	1 5. 2	7 6
試料 2	2. 5	7 8. 1	2 0	1 0. 0	5 0
試料 3	2. 0	6 2. 5	3 7	3. 0	1 5
試料 4	1. 8	5 6. 3	4 5	0	0

[0022] The slurry which mixed a main ceramic ingredient, a main solvent, etc. was prepared, and the green sheet was produced with the doctor blade. As shown in drawing 2, the silver paste electrode material was screen-stenciled to this green sheet, and the electrode pattern 3 was formed in it. This was made into the 1st layer, the laminating of the green sheet which is not printing an electrode on it was carried out,

and the layered product of structure as shown in drawing 3 was obtained. This green sheet was formed in the chip with a 20mmx20mmx height of 1.0mm using the thing with a thickness of 100 micrometers. Subsequently, the ingredient of the samples 1, 2, and 3 of Table 1 was used as the 2nd ceramic ingredient, and this, a solvent, etc. were mixed, it considered as the shape of a paste, and printing formation of the paste of this 2nd ceramic ingredient was carried out by screen-stencil at each chip. This schematic diagram is shown in drawing 1. In 1 of this drawing 1, a main ceramic layer and 2 show the 2nd ceramic layer, and 3 shows an electrode pattern. And the thickness of the 2nd ceramic layer 2 was changed and it calcinated at 900 degrees C. And the deformation of a burned product was investigated. This result is shown in Table 2.

[0023]

[Table 2]

	第2のセラミック層 の試料	第2のセラミック層 の厚さ (μm)	変形量 (mm)
比較例 1	—	0	1. 4
実施例 1	試料 1	1 0	0. 5
実施例 2	"	2 0	0. 4
実施例 3	"	3 0	- 0. 2
実施例 4	"	4 0	- 0. 7
実施例 5	試料 2	5	- 0. 3
比較例 2	"	1 0	- 1. 8
比較例 3	試料 3	5	- 1. 2

[0024] In Table 2, deformation made deformation the overall height D of a chip (mm) to thickness [of a chip] d (mm), and D-d, as shown in drawing 4. In addition, it is shown that minus curved in the reverse side. The example of this invention had little deformation and was able to control deformation as I understood from this table 1. Moreover, the 2nd description and thickness of a ceramic layer show that deformation is controllable. By the sample 3 (% [of void contents / 37], % [of rates of a density ratio / 62.5], 15% of contraction ratios), the deformation of the reverse sense was large and was not practical.

[0025] The effectiveness which controls the deformation at the time of baking becomes large so that the ingredient of the 2nd ceramic layer has many contents of elevated temperature temporary quenching powder, but since the void content of the 2nd ceramic layer rises too much, reinforcement falls, the adhesion fall of the terminal electrode for connect an external circuit on the strength is produce, or it becomes easy to absorb moisture, the fall of dependability and increase of the dielectric loss of an ingredient are imitate, and the problem of **

occurs . For this reason, although the void content of the ingredient of the 2nd ceramic layer serves as a larger value than the ingredient of the 1st ceramic layer, it is desirable that it is 20% or less. Moreover, although the consistency of the ingredient of the 2nd ceramic layer serves as a value smaller than the ingredient of the 1st ceramic layer, 70 - 95% of the ratio is desirable.

[0026] In the above-mentioned example, although printing formation of the 2nd ceramic layer was carried out in the end side of a ceramic layered product at the whole surface, printing formation may be carried out inside a layered product. Moreover, in addition to printing formation, the 2nd ceramic layer can be fabricated in the shape of a sheet, and can also carry out a laminating. Moreover, according to an internal circuitry, the 2nd ceramic layer may be partially formed in the interior or the front face of a layered product. This example is shown in drawing 6 . The arrays of that electrode pattern differ partially, this drawing 6 doubles with it, although the electrode pattern 13 is built in in the main ceramic layer 11, and the 2nd ceramic layer 12 is also arranged partially. Such structure serves as an effective technique especially in a large-sized substrate. Thus, the 2nd ceramic layer can choose the location to form, thickness, and description according to the internal structure of a ceramic layered product.

[0027] According to the example of this invention, even when an internal electrode pattern is imbalanced in the direction of a laminating, deformation can be controlled by forming the 2nd ceramic layer. This 2nd ceramic layer is a main ceramic layer and this main presentation, and can be completely unified after baking. Moreover, an exterior is also excellent. Moreover, more greatly [a void content] than a main ceramic layer, the consistency formed the 2nd ceramic layer as a small layer, and it has controlled deformation.

[0028] Above, although the main ceramic layer explained the structure currently formed with the one quality of the material, it can use the technique of this invention also in the compound layered product which consists of two ingredients, the magnetic substance and a dielectric, for example. When an electrode pattern is formed in the interior and deformation arises according to the imbalance of that electrode pattern also in this compound layered product, it is possible that deformation arises by the difference in the description between different ceramic layers, but even if it is which case, in order to control deformation, it can be understood easily that above-mentioned this invention can be used. That is, this invention is included also when it consists of two or more ceramics from which a main ceramic layer differs. Moreover, as

for the 2nd ceramic layer, it is desirable at this time to use the same component as one side of a main ceramic layer.

[0029]

[Effect of the Invention] According to this invention, in the ceramic layered product which has an electrode pattern inside, in the direction of a laminating, according to imbalance etc., even if internal electrode structure is the structure which is easy to produce deformation, it can control deformation, and raises the quality of a ceramic layered product, as a result leads to the improvement in a property of an application article.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is structural drawing of the example concerning this invention.

[Drawing 2] It is electrode structural drawing of the example concerning this invention.

[Drawing 3] It is structural drawing of the example of a comparison concerning this invention.

[Drawing 4] It is drawing showing the deformation concerning this invention.

[Drawing 5] It is the explanatory view of the conventional example.

[Drawing 6] It is structural drawing of another example concerning this invention.

[Description of Notations]

- 1 11 Main ceramic layer
- 2 12 2nd ceramic layer
- 3 13 Electrode pattern

[Translation done.]

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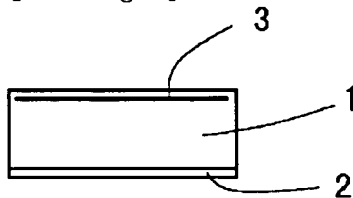
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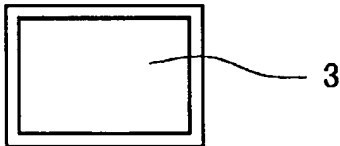
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DRAWINGS

[Drawing 1]



[Drawing 2]



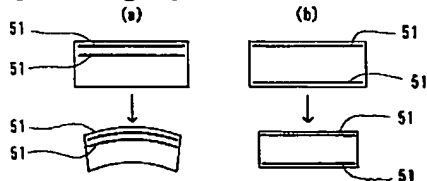
[Drawing 3]



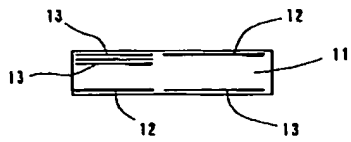
[Drawing 4]



[Drawing 5]



[Drawing 6]



[Translation done.]